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A HERD OF DUTCH BELTED HEIFERS

They show the standard pattern: note the remarkable uniformity in size and position of the belt, which is located in the same relative position as on the horse and the Indian Tapir. These Dutch Belted cows present a delicate problem to breeders, because the introduction of new blood, even though from a pure strain of the same variety, may upset the perfection of the pattern, just as is the case with the finest Barred Plymouth Rock fowls and Hampshire swine. Photograph from L. K. Hildebrand. (Frontispiece.)

COAT-PATTERN IN MAMMALS

A Medium of Real Value to the Breeder, Since it Enables Him by Analysis to Detect in Many Cases the Genetic Composition of His Animals—Mendelism in the Hands of the Fancier.

Q. I. SIMPSON, *Palmer, Illinois*

COLOR, or coat-pattern, is of little commercial importance on domestic animals destined for pail or plow, while it is entirely lost at skinning if the animal is destined for slaughter. Nevertheless, it has a real value to the fancier as a means of determining the purity of his breed, as well as to afford him a source of scientific entertainment. In the case of most pedigree breeds, pattern and color are an integral part of the standard score-card, and therefore must receive consideration from the breeder who handles pedigreed stock.

As the origin of most breeds is known, the latencies which they contain are of use to the analyzer. One of the most striking features which can be dealt with in this way is the white belt which is a feature of the colored coat of many mammals.

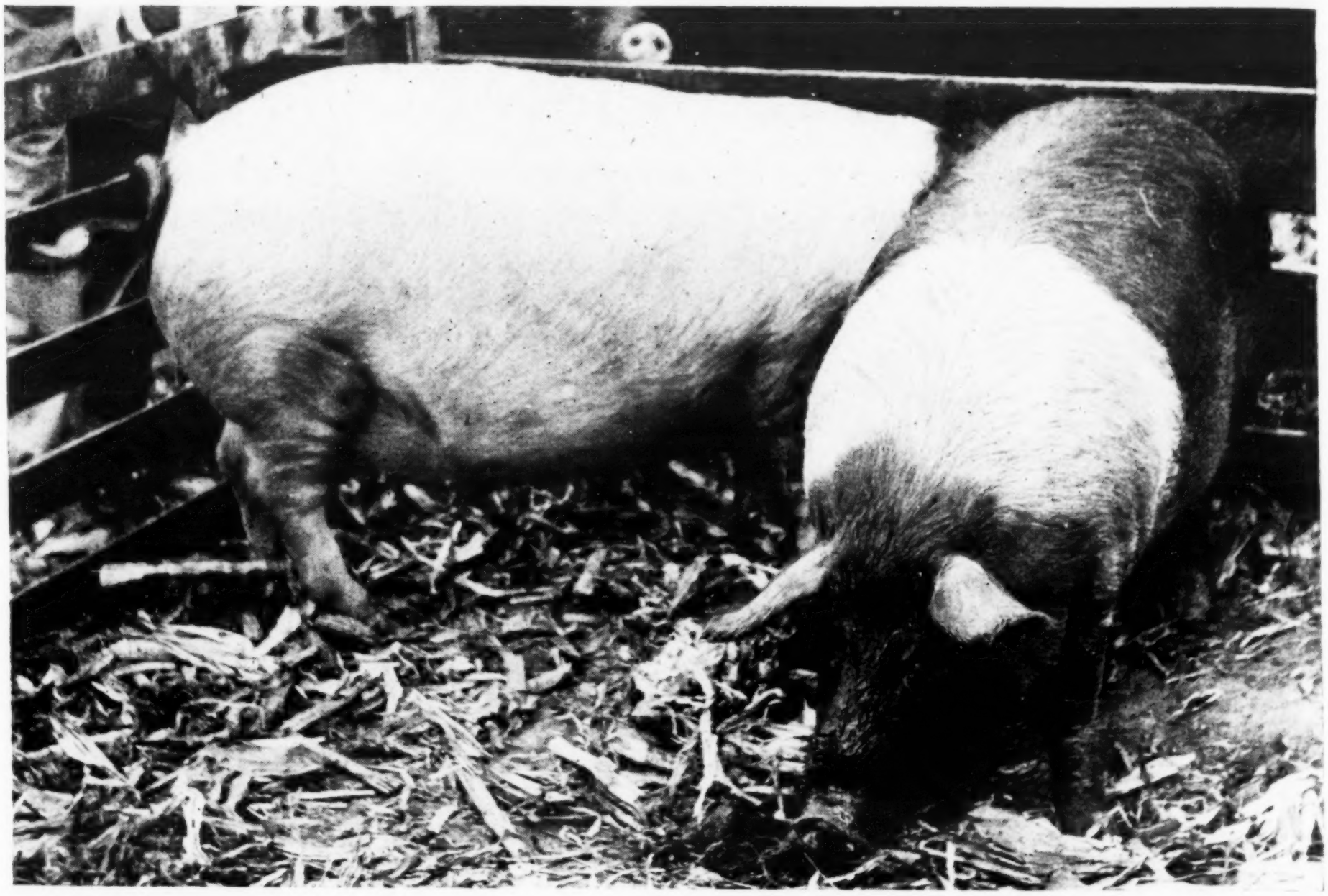
It is of relative location regardless of its dimension. In swine its center falls in the shortest line measuring over the shoulders from toe to toe, except in the latent belt of the Red Duroc, which is located farther back. So nearly in the same place is the belt regularly located on all swine, that it must be believed a peculiar cell-localization, belonging in general to all species of Suidae in latent condition.

W. J. Spillman of the United States Department of Agriculture was perhaps the first to publish a genetic hypothesis regarding the white belt in mammals, basing his opinion on his observations in my own herds of hybrid swine; and it is due to the stimulus received from him that I began to take an interest in this character. We had undertaken by reciprocal crossing of contrasted breeds to decide an important genetic question: the potential hereditary value of sex, the potency or hyper-potency of male or female. While this series of experiments was in progress, Mendel's Principles of Heredity were uncovered, adding more facts and greater fascination to the work.

FOUNDING A NEW RACE.

Among the hybrids on which we were working, we found synthetic belted pigs in the white contingent of the second Tamworth cross on White Yorkshire. Pigs with white hair but clouded skin, F1, were bred back to pure Red Tamworth, getting the straight Mendelian ratio of 2:2, whites and reds; but some whites remained white only until they were weaned. Red hairs then began to appear throughout the front and hinder areas, making in different subjects varying degrees of red-roan. Some even gained clean, white belts, located as in the Belted Black Hampshire. Looking back to these various belted red-roans, I now believe that clean red-end Belts could have been selectively evolved by interbreeding the reddest. In that case, my new race of Belted-Reds would have been better founded than by the method which actually produced them—namely, crossing these synthetic belts with the black-end Hampshire; for with the latter operation I lost time in cleaning away, by elimination, the Hampshire black.

Belted swine offer the seeming paradox of explanation by postulating one factor or two factors. An explanation will make this clear. Taking the red Tamworth, or the wild Sus from the Schwarzwald, any addition of the proper potential of unspotting white from a White Yorkshire will produce some clean white belts, with incipient pigment of the



A PRACTICAL PROBLEM FOR SWINE BREEDERS

Here is a pair of pure-pedigree Hampshire sisters from Dr. Flower's herd. The one at the right represents the standard pattern, the other shows an enlargement of the white belt until it covers the whole body, save for the head and tail. How can such an excess of white be corrected in breeding? Mr. Simpson says some breeders have used an all-black "throw-out" male for mating with sows of this type, and the results in the first generation are succesful. Relief is only temporary, however, for the second and third generations break away into black and white "throw-outs," just as is the case with Blue Andalusian chickens. (Fig. 1.)

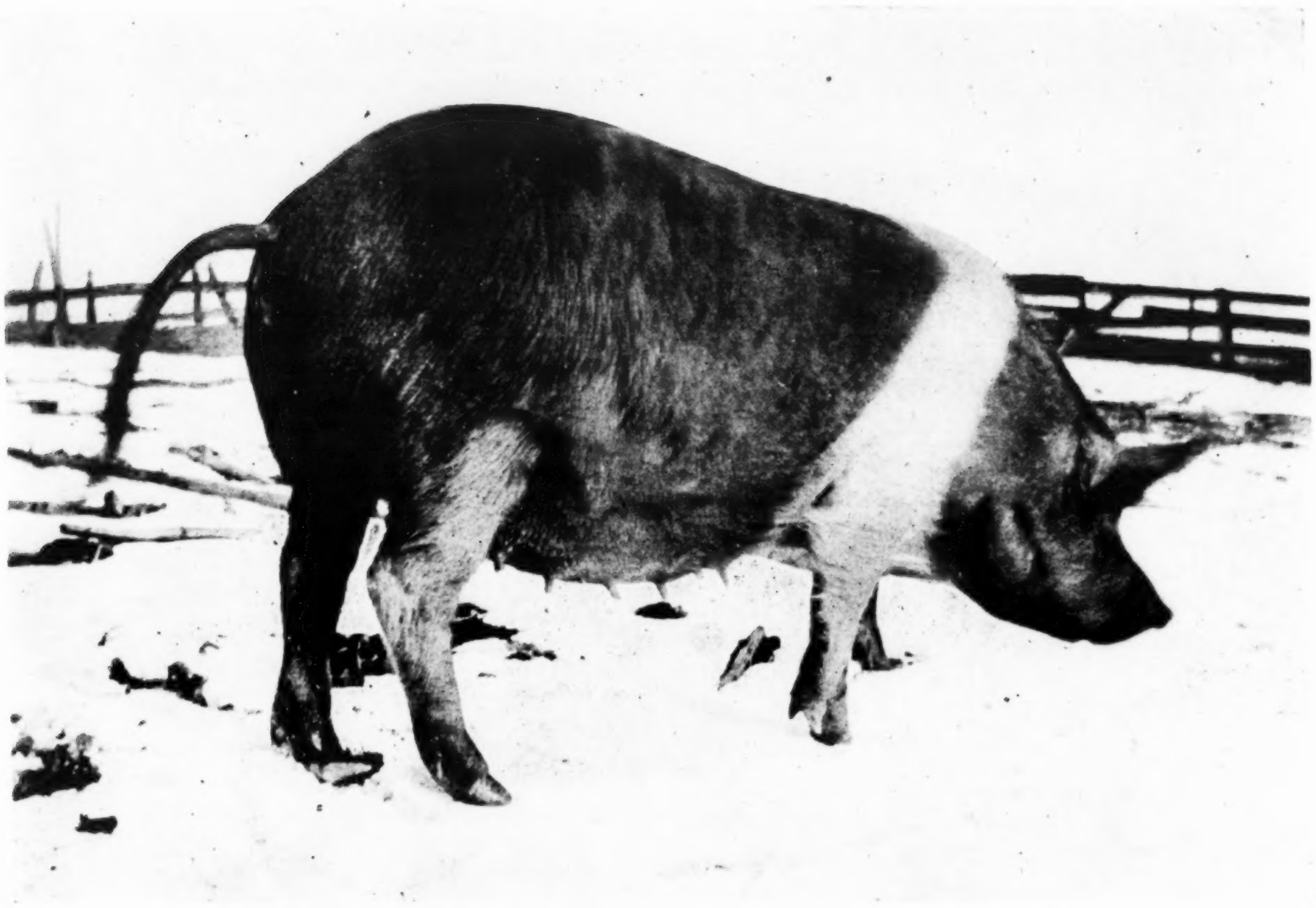
outside area that delineates it. Then we might say that the white belt of swine is composed of a single factor, this dominant, and being simply the same factor that can produce a rather low potential of dominant white. But when a Belt is crossed, or white added, with breeds that exhibit, or carry latent, spots in the pigment area, it must then be compounded of two factors: one the white, the other a determiner for selfing the pigmented portion of the pattern. The first of these factors (the white) is dominant; the second (the selfing) is recessive.

Spotting on swine, as with other mammals, may be of two kinds: pigment spots on a white field, and white spots on a colored field. I can readily recall the founding of a noted breed of swine that was white with small black spots but now, by the selective fancy of its breeders, has gone through such an evolution that it has become nearly pure black, with a few white spots.

INHERITANCE OF BELT.

With a pure Hampshire male from President Goodwine, the white area of belt was dominant over some pure breeds, but in lower per cent. with cross-breds. The selfing was of vascillating recessiveness, verging to dominant in some crosses. From this boar on a pedigree Poland-China sow, that was clean black except the six white points, a brood of 13 pigs was born, all clean white in the belt of fairly uniform width; but seven of the litter were so much covered with spotting in the desired black area that they would not be taken for Hampshire hybrids.

As would be expected of white-face, stocking-legs, spotting, or pattern de-



THE BREEDER'S TEST FOR PURE PEDIGREE

A yearling sow, out of a tested Belted Red sow. and a supposedly pure Tamworth sire. Contrary to expectation, she has an all-white hind leg. Such a trait does not belong to either of her parents; Mr. Simpson is convinced that it shows a Berkshire taint in her supposedly pure Tamworth sire. (Fig. 2.)

pending on two colors, the width of white belt in Hampshire and its hybrids, or synthetic belts, varies in dimension from the entire pig white except head and rump, to all black except a narrow white line, or only the front feet white.

With the Hampshire of pure pedigree there are a few all-whites and some all-blacks. The factor for making white in the belt and the factor for selfing the anterior-posterior coat seem to be always in contest for supremacy: and both must be in happy equilibrium to produce the standard pattern. I have made apparent proof that either of these factors may be strengthened against the other by the conscious addition of other factors that work to the help of one of them. And illustrating:—Some red sows were selected that were the second Duroc top on Poland-China: out of a numerous bunch two sows were found free from white-spots or markings that indicate a hyperpotent red drowning the latent spotting of the Duroc and the white-spotting factor of the Poland-China. These all-red sows were bred to pure Hampshire, that normally should sire 100% belts: but the result of their 21 pigs was 11 self blacks and 10 belted of various but very narrow width, the ends of good Hampshire black. From other hybridizing with the same boar I believe that had we selected from the same broods as these hyperpotent red sows some others showing spots of white we would have gotten near 100% of Belts. We may say that both factors for belting pattern are Mendelian, but must provide that no other element interferes.

Belted pigs are occasionally met among several crosses free from Hampshire, Yorkshire or Tamworth blood. My recollection from childhood days, when my father was improving the native black hog of Illinois with a mostly white hog from Ohio, is that there was about 5% of belted pigs that were called by the settlers "listed-hogs." And in

Southern Indiana, where improvement was not undertaken until later, the Hampshire breed undoubtedly took its origin in the same way.

ANOTHER BELT FORMULA.

In searching for a belted-red male for outcross to my Belted-Reds, I found a pig without pedigree, of perfect belted-red pattern. He was from a herd in which the owner had variously used Chester-White and Red-Duroc males on a black Poland China foundation. Out of some 60 pigs he was the only one of the belt-pattern. Before using him we loaned him to a breeder having a large herd of sows that were a mixture of Duroc, Tamworth, Yorkshire and Poland in various proportion. In this herd he sired nearly 15% of belts, giving us some confidence that he would sire normally to our fixed-belt sows. But the result was no better than from the mixed herd, and we surmised his factors for the belt were compound and entirely different to the two-factor class with which we were breeding: acting against our older factors as opponent rather than aid. The few good belts from him were also sadly upset in their transmission, throwing pigment spots inside the widest part of the belt, white spots on the pigment area, white bellies and white high on hind legs (always on same pig with white-belly). May we suspect that his selfed area was the result of two different spottings, one interposed on the other, bridging the pigment voids?

Two broods by the Goodwine pure Hampshire out of two hybrid sows I will describe to illustrate pattern genesis:—These sows were of two Red-Tamworth tops on a pure white Yorkshire foundation: designated in farmlore as ¾ Tamworth, ¼ York. In color-area one was a light-red-roan, the other dark-red-roan, and each had a normal white belt; their broods aggregated 16 pigs, enumerated:—Three perfect Hampshires; three wide belts on brown-roan ends; two standard belts on pale yellow-red ends, with a large black-spot on each at top of rump; two Hampshire-black with belts except these narrowed to extinction on each at top of shoulders; one good red coat with narrow belt closing at top of shoulders; one mostly white (an extravagant belt) leaving only a black spot on rump and at root of ears; one incipient belt, one fore leg only being white and the rest of the body good red except for small black specks on rump; three hair-coats all white, skins splotched with black.

Analyzing these:—the mothers were each heterozygous in the white factor for belting, getting this only from the Yorkshire side of their pedigree. That they were also heterozygous for the selfing on pigment area is proved by their roanness, of mingled red and white hairs, which came only from their last Tamworth cross. The white factor from the Hampshire was dominant in the entire 16 pigs in some degree, from the single white leg on up to the three pigs entirely covered with white. Had these same belted-roan mothers been bred to a sire of their own color and genesis, our like crossing has proved that their produce would have been 3:1 whites and reds, with a per cent. of the whites turning roan towards maturity, and some with belts.

ANALYSIS BY ANALOGY.

So far the analysis was simple: but looking at the result of adding the recessive selfing factor of the pure Hampshire with the various complements that this must encou[illegible] in these heterozygous sows, the e[illegible]nation can only be the crudest guessing. Again, however, we have precedent in other hybridizing. The Hampshire being full dominant to Tamworth Red, we may conclude that the first three pigs, named as perfect Hampshires, resulted from segregation of these breeds in the zygote. Actual breeding is the only test to determine whether they are heterozygous or homozygous for the white factor of the belting which, it will be remembered, is dominant. The next three pigs, brown-roan ends with wide belts, appear to be of Yorkshire-white plus the two belt-pattern elements from the Hampshire; except that there remained also in the ova one or more Tamworth pigment-forming genes which caused the

SOME COMPLICATIONS IN MENDELISM

Emma D. 71, a Belted Red sow, sired by a pure Red Tamworth boar out of a Belted Red sow, tracing back in the maternal line to a Hampshire boar on a light-roan-belted hybrid sow. Although she appears true to type she is of decidedly mixed descent. The question of interest to the breeder is to know how she will behave in breeding. She was mated to a Belted Red boar which was also a Tamworth-Belt hybrid, and farrowed 18 pigs. Eleven were belted, while seven were recessive reds. Had the parents been of pure blood instead of mongrels, all the pigs would have been expected belted. It is interesting to note that the black of Hampshire has been completely eliminated, both from body and germ cells, in this sow, as far as the analytical test of breeding shows. (Fig. 3.)

scattering pigmented hairs in the selfed area (the Hampshire selfing factor is recessive to pure White Yorkshire).

The next two pigs with their standard belts, pale diluted red at each end with a black spot in this on top of the rump, appear to have resulted from the pairing of enough Tamworth-red entities from the dam, which uncrossed would produce a highly potent yellowish-red, which is often found among the recessives of the F2 Tam-York cross. The added dominance of these two pigs was perhaps received from a single Yorkshire factor, with the dominant and recessive factors of the Hampshire sire.

The next two pigs, good Hampshires save that their belts narrowed to zero on top of the shoulders, should be classed with the first three of Tam-Hamp composition, only in these the selfing factor was more potent against the belting. The next two pigs, red with a narrow belt not continuous at the withers, are like the belts with yellow-red, except that the hyperpotent red from Tamworth, by Yorkshire acceleration, is yet more dominant against the Hampshire black. The next one, which was nearly all red with only the left fore-leg white, might be classed with the last foregoing, except that his belt was more incipient.

The last three pigs, with coats all white and skins mosaic, should be the result of crossing nearly pure white Yorkshire with the pure Hampshire. Evidently none of the Tamworth selfing factor was left in the conglomerate eggs.

We learn from these experiments and from direct crossing of the White

Yorkshire and the Red Tamworth, something of the elements that make each perfect in the colors belonging to its breed. And we also find that Mendelism may not be condemned without due analysis of contending factors that may be contaminating germ-cells. To make lucid I will try your patience with some meditating on Yorkshire and Tamworth color-origin.

THE YORKSHIRE WHITE.

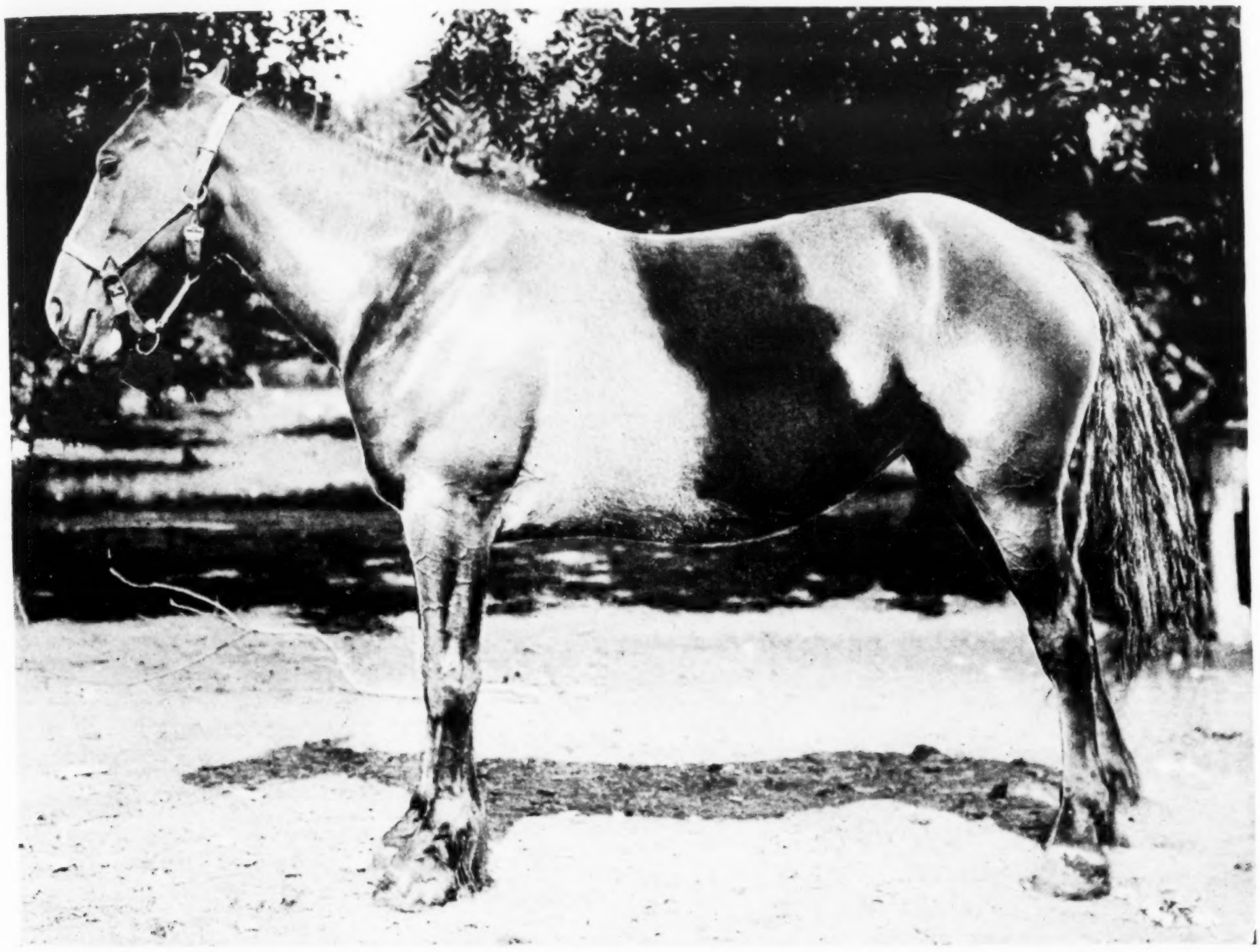
Yorkshire white must be treated as a pigment or coloring, the same as in the paint-shop, and not as the absence of something: for all white of swine known to me is dominant to the darker pigments, when crossed against them: analogous to the brown, red, and gray lead oxides that carbonated and further oxidized produce the whitest paint.

We would imagine the origin of the White Yorkshire that has some genealogy, to be from the white hog of China, where perhaps most of his perfection in whiteness arose before importation by the Bakewells to England. Being dominant white we can not suppose its first exhibit to be by the meeting of chromosome complements, as with albinos, (the pairing of two recessive chromosomes, one from each parent, making the somatic exhibit in purity). Nor may we guess that the first mutant was of such potentiality in dominance as is the single factor producing white in the family of spotted Negroes which I will later mention. Analysis of this Yorkshire white, which I have made by hybridizing, proves the main factor only to be dominant: and this the factor that singly, in heterozygous pairing, whitens every hair on the entire coat at birth, but has not the power to whiten the skin of the same subject. This single mutant factor could have acquired its present potentiality at a single leap, or may have reached its present stage by long continuous selection: we know of no analysis for deciding this. A single factor, by its presence or absence, says white hair or colored hair, as we have deduced by Mendelizing. But for the perfection of white in the skin from which the white hair grows, and the positiveness that all the hairs shall still be white at maturity of the subject, throughout the entire coat, we must postulate the doubling, or homozygous pairing, of the factor for white. We see in the jack-rabbit of the plains from Texas to Alberta, the progressive whiteness in which every degree of duration of Winter's snow adds to the perfection of his invisible snow-coat. And might not the white hog of China have gone through the same minute, selective steps of variation towards perfection, by the constant desire of his Mongolian breeders? That there is at least one factor in the Yorkshire of high oxidizing power is indicated by the fact that a portion of F_2 recessives of this breed and of the Tamworth, are richer in tint (red), and more potent in crosses, showing improvement over the red of pure subjects. Thus we find a perfection of "paint making" among the extracted recessive reds from the Tamworth-Yorkshire cross: a few of these being much more brilliant in exhibit, and more potent in further Mendelizing against other breeds.

The Tamworth, now desired a bright-red, is of lineal descent from the wild gray *Sus scrofa* of Europe. We know this from scattering history of his Irish origin, and have greater proof from hybrid analysis. It seems yet to require some selecting to prevent his reversion to the dark wild gray, now carried by the indigenous hog of the Schwarzwald. His skull-formation, though not his dentition, seems good evidence also of his *scrofa* descent. While the Tamworth is termed red, there are various shades and tints of this: a yellow-red that fades in maturity to dirty buckskin; bright-red keeping good to old age; and a ripe-cherry-red turning slaty-black at maturity of pig. And while the main factor that decides red is found in all the shades, there are no doubt other heritable factors shuffling in or out at formation of the gametes, saying by their presence or absence which particular tint will be made in the coat.

PATTERN CORRELATION.

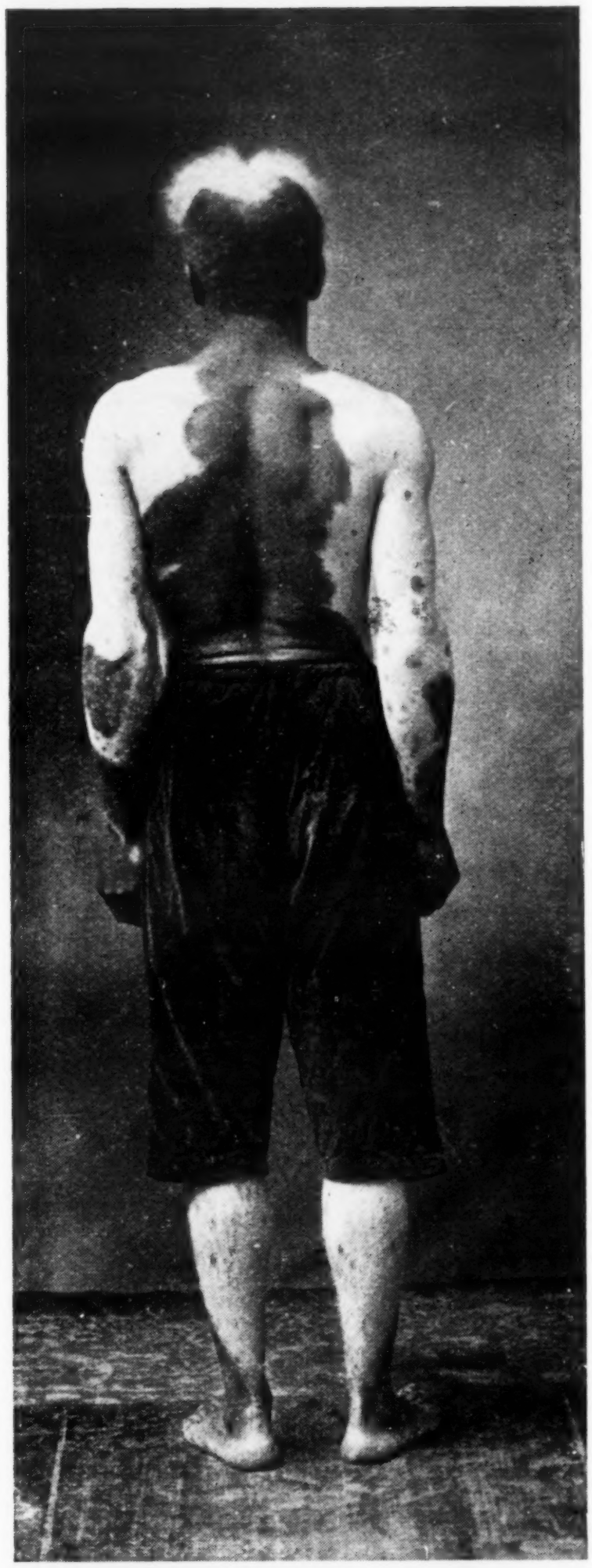
Dropping back to the discussion of outlining in color-pattern with white and red, we will cite some observation:—



AN UNUSUAL HORSE BELT

Bright bay mare with a seal brown belt encircling the body in the position where piebald horses carry a white belt. The inheritance of this mutation was not tested further than two colts that were normal. Photograph by Spillman and Simpson. (Fig. 4.)

Two hybrid belted-red sows, one with belt on left side only, the other with belt only on her right side, and each devoid of white on opposite side where it should be white, were each bred to a pure Red-Tamworth male, causatively for ascertaining the action of orientation in the first two cells of the blastomere, and the polar localization of the front and hinder ends of the lateral pair of cells, to be determined by the pattern of their produce. To our surprise, in the goodly number of young from each sow there were no half-belts; and on those having preponderance of belt on one side, these did not correlate with the unsymmetry of their dam as to same side: for there were as many of right-maximum from the left-belt sow, and as many left-maximums from the right-belt sow. There were too as many perfect belts as from normal belt sows, under Mendelian expectancy. This could be explained on the assumption that the cytoplasm had effected pattern proportion at the two-cell stage of the unsymmetrical belts. If in the two-celled stage of development these had sundered, as is supposed in identical twins of man, these one-side belts would have each given phenomenon of "identical twins," one of each belted, the mate entirely selfed. I believe T. H. Morgan has found vinegar-flies (Drosophila) that had the right eye of one color and the left of another, and the same has been seen in man. We have, however, other evidence, that the size of spots in a pattern, and their location, is the effect of a lineal family of chromosomes, that at a fixed number of generations from fertilization reach differentiation. This is shown by paired anterior-posterior markings; and also by the fact that when a spot is found on one side, its mate at the same location may usually



ALBINISM IN MAN.

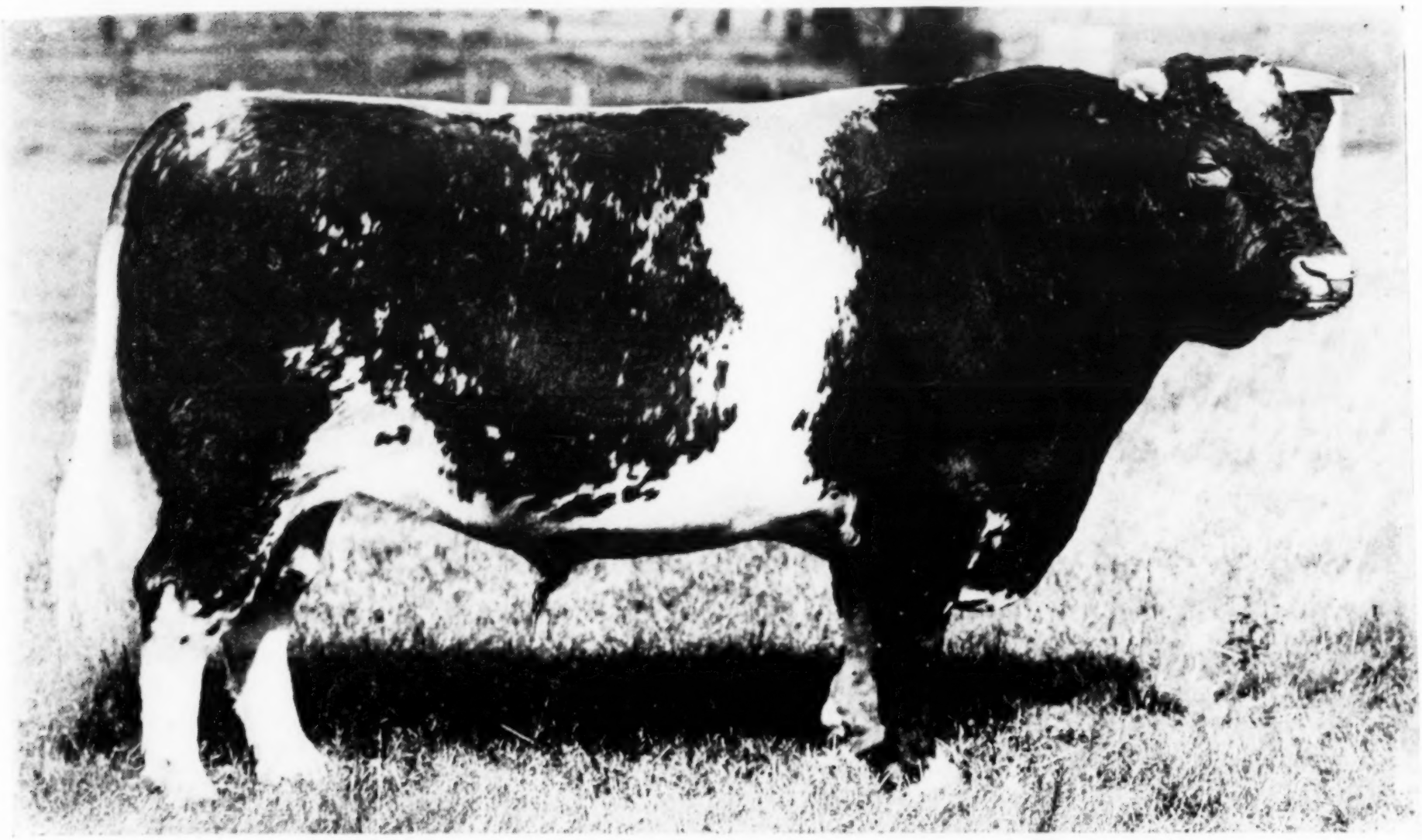
Seventeen spotted and 16 normal negroes are the aggregate descendants of Mrs. S.* A.*, a spotted mutation who founded a new race. This photograph represents her grandson, Jim D*., whose father was a wholly normal Negro. The white factor running in this family acts, in heredity, like the white factor for belting in swine, and is dominant. The width of the black stripe varies among the individuals, but all are white in front. Photograph first used by Simpson and Castle in the American Naturalist. (Fig. 5.)

be found on the other side. In several hundred observations of black switch on tails of Jersey cattle, no instance was found where the tongue was not also black; there are nearly as many Jerseys found with white switch, but these all have white tongue. An interesting subject was a heifer with a gray switch, (white hairs and black hairs being mingled in equal numbers), and the tongue was neither white nor black but a blended blue. This works also with the black-end Hampshire swine, where a few have undesired white on end of tail: nearly universally will it be found that the nose, sometimes only the center of the rooter, will be found of white skin. The pairing of white spots or black spots with near equality in size is found to some extent on nearly all domestic animals bearing spots on the coat: and only rarely, when the spot is quite small, will a mate not be found at the opposite side. This seems to prove causation.

The conception that size of color-area is dependent on the age at which differentiation occurs simplifies the phenomenon of pattern, whether the entire coat be a unit, or each individual feather of a fowl be the unit as with Barred Plymouth Rocks. With feather-barring, Oscar Riddle found that the white bars and the black bars were each all laid down on all the feathers belonging to the one bird as they were growing from the follicles at fixed minimum and maximum periods of the bird's body-temperature and blood-pressure: simulating the congestive coldness and subsequent fever-reaction of third-day malarial ague.

HETEROZYGOUS PATTERN.

When the pattern of individuals depends on the hybridity (heterozygosity) of paired chromosomes, it can not be heritably fixed: and concrete illustration is found with the roan-shorthorn, Blue Andalusian fowl, and at least two lines of spotted horses in America. With these horses (though not with the spotted Shetland pony, which is patterned by different factors from these), this spotting is the result of two



RINGMASTER, A GOOD TYPE OF ROAN SHORTHORN

The usual location of the belt in this breed is indicated. Neither the roan color nor the belt pattern can be heritably fixed, being the result, Mr. Simpson thinks, of a single white factor and a single red factor paired in the primordial sexual cell or zygote formed by the union of sperm and ovum. Roans are produced in 100% when all-red and all-white animals are mated; but when roans are mated together, only half of the produce are roans. In other words, the pattern is strictly heterozygous, according to the experience of breeders, but it can be created anew whenever it is desired, by the mating of pure white and pure red individuals to produce the required heterozygous pattern-determiner. (Fig. 6.)

equal and semi-dominant elements: one for making all white, the other for making all color; and these two factors are proved by breeding test to lie in the same chromosome pair. Thus when heterozygous, they create a spotted animal; when the white is doubled (homozygous), the individual must be all-white; when the color-chromosome is doubled the animal is selfed, and may be either bay, brown, chestnut, or black, according to its inheritance. The Mendelian ratio from a spotted mating is 1:2:1, white, spotted, colored: the same as the ratio from conjugating roan Shorthorns. Both the white and the self from spotted matings have proved, in my observation, pure and homozygous. The spotted Shetland acts like the spotting of pure Holstein cattle, and does not segregate. A peculiarity of the selfs from spotted matings is the absence of the usual white points, indicating that this selfing factor is different from the ordinary factor that produces standard colors in horses, most of which bear white markings on feet, legs or face.

Dr. Frank R. Lillie referring to Holsteins, of which for a number of years he has maintained an extensive herd of pure-breds, tells me:—"I believe that it is possible to breed for white or black, but results are surprising. One of our bulls (very white himself and of whitish ancestry) certainly puts more white on his calves from the same cows than the darker bulls. A pure black Holstein is an impossibility, I believe; if there is any black below the knees you can be sure of mongrel blood. The nearest we have come to pure white is in the case of a young heifer with a black tip to one ear and a black spot the size of a half-dollar on the neck. I think it would be possible to soon breed the black out."

Among the freaks of factor combinations which I have seen, was a percent. of striped-roan pigs, the produce of the second Schwarzwald-wild top on white

Yorkshire: these with seven longitudinal red stripes on a white-roan field were found in the clsss of dominant whites (at birth), acquiring the stripes after the weaning moult. At this time other important genetic problems prevented our testing the possibility of fixing the unique pattern. Its make-up was from the black birth-stripes of the wild scrofa, which are obliterated at moult, with a weak dominance of Yorkshire-white as the other factor: and a peculiarity was the fact that, unlike their prototype, the dark stripes became darker, the white-roan field whiter, as animal progressed in age.

We may safely predict that any form or design of color or pattern, be it belt, stripes, white feet, or spots in any particular locality, may be fixed to reasonable heredity dependent on homozygous pairs of chromosomes, regardless of the number of factors involved, so they fall inside of the species number of chromosome pairs. But no pattern or design can be regularly perpetuated where the factors are split in the pair, *i. e.*, when depending on any heterozygous pair of chromosomes.

THE USE OF MENDELISM.

Recapitulating we say:—The Fancier and the Mendelist may synthesize color and pattern to their likings. Starting with dominant white found on some individual, family, or race, among mammals or fowls, he may borrow from another of the species the dye, from yet another the stencil, and create unique marking. Then with simple Mendelian analysis will he prove, as with chemistry, the possibility of fixing to heritable perpetuity his hand-made design. When the particular type has been trued and standardized by selective elimination; homozygotized in each pair of chromosomes constructing it; and the race from which each pair of these was taken is known, then will he possess a delicate "C. P. reagent" for finding the most minute contamination in a suspect belonging to breeds with which he is familiar.

The fancier's Blue Andalusian is the hybrid of black and white; the spotted horse and the roan shorthorn are the hybrid dominants of white and color factors belonging to the same zygotic pair, always paramour in the sex cells and somatic cells: and such can never be fixed by breeder's selection: but they may be created *de novo* in 100% when an animal with one of these factors doubled is mated with another with the other factor doubled; so that at the halving of the chromosome pairs in egg and sperm to create the new life, this receives the paramour that creates the pattern.

Conceiving that areas of color markings are modified by the time of differentiation in the blastomere or embryo we then have a pleasing hypothesis for the fact known by feather-fanciers and pattern-breeders that the stable, standard pattern is upset when to a line of long inbred fowl or mammals an outcross of pattern of the same appearance is introduced. In my own experience and gleanings I find usually that the F1 individuals of the outcross are usually unchanged; the F2 and later generation show the bad breaking-up of color proportion and equilibrium. From this may we surmise that the nicely balanced barring on a "Felch" strain of Barred Rocks depends on exactly so many days and hours between the minimum body temperature and blood pressure, producing the white, and the same time period of maximum temperature and pressure producing the black, staining the colorless gell that is constantly passing out of the follicle. Then if there is introduced an out-cross of the "Barnes Strain" having a difference of congestive period, we would get the "breaking-up" of the correct barring by interposition of black on white.

Breeders of the now popular belted hog, the Hampshire, have not attended to the effect of outcrossing on their families, so that when they add new animals, the breeder of these has been accused of sending hybrids. May we moralize that the new dose must be cautiously tested before general use.

Let me add: that Mendelism, the result of chromosome shuffling and seggregation at the sexual preparation of egg and sperm, is the breeder's fractionating column and analytical balance: it enables him to separate and weigh the determining entities that make visible the types, and then to resynthesize these to his uses and his fancies.

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Hemophilia in Horses

That blood-vessel breaking in race horses is an inherited character is argued by J. B. Robertson in the *Bloodstock Breeders' Review* (II, 4, 265), who traces the beginning of the trouble to Herod, an English Thoroughbred foaled in 1758. Only one runner out of 400, each year, breaks a blood-vessel, but Mr. Robertson shows that the animals which do so are all found to be related, and apparently to carry this pathological factor as a recessive in either sex. Ordinarily, he remarks, "a true recessive character, such as chestnut coat-color, only becomes patent in the individual when a determining factor for it has been inherited from both parents," but it appears to him that "in certain characters which depend on structural or physiological peculiarities and which are marked departures from normality, one intense dose of the usually latent or abnormal character may be sufficient to overcome the normal condition, which has been inherited from the sound parent."

Inheritance in Poultry

Several suggestions regarding inheritance in domestic fowl are made by D. F. Laurie, poultry expert of the government of South Australia, in his report on Egg-Laying Competitions held at Parafield in 1913-14. "I would again impress upon breeders," he remarks, "that the reappearance of broodiness among White Leghorns is a taint, even as are cases of colored feathers. Both can be eliminated, but only by strict and accurate methods of breeding. . . . To breed from a hen which at any time has shown the slightest indication of broodiness is in my opinion the height of folly." The instinct to brood may be transmitted through the cocks, the breeder is reminded. Mr. Laurie also considers egg-shell color to be a transmitted character, subject to dilution or masking. There seems to be some correlation between tinted shells and broodiness. It is considered possible that the habit of laying tinted-shelled eggs appears only in alternate generations. Experiments are now under way which are expected to yield definite conclusions on these points.

THE EUGENICS COMMITTEE

To aid in guiding public interest in eugenics along scientific lines, and to increase this interest by propaganda, the President of the Association has appointed the following as members of the Committee on Education and Extension, which was created by the council of this association last winter:

David Starr Jordan, Chancellor of Leland Stanford Junior University, California (chairman).

Dr. Rupert Blue, Surgeon, General U. S. Public Health Service, Washington, D. C. (first vice-chairman).

Mrs. John Hays Hammond, former National Chairman, Woman's Welfare Department, National Civic Federation, New York, N. Y. (second vice-chairman).

Dr. W. C. Rucker, Assistant Surgeon General, U. S. Public Health Service, Washington, D. C. (secretary).

Irving Fisher, Professor of Political Economy, Yale University, New Haven, Conn.

Dr. Elnora Cuddiback Folkmar, Superintendent of Women's Auxiliary Clinic, Washington, D. C.

Mrs. Charles Cary Rumsey, New York, N. Y.

The Very Reverend Walter Taylor Sumner, Dean of the Cathedral of St. Peter and St. Paul, Chicago, Ill.

Talcott Williams, Dean of the School of Journalism, Columbia University, New York, N. Y.

Mrs. Huntington Wilson, Washington, D. C.

The letter of invitation sent to those selected as members (all of whom have accepted) states that "The object of this committee will be to promote the education of public sentiment throughout the country, in order that a 'eugenic conscience' may be formed in as many individuals as possible; to oppose premature legislation and, if necessary, to suggest desirable legislation, on the basis of scientific data. The work of this committee will be focused in the organ of the association, THE JOURNAL OF HEREDITY."

The committee expects to adopt every means possible to further the interests of conservative and constructive eugenics, but its principal work, for some time at least, will probably be the formation of local societies for the study of the subject, the arrangement of public meetings and lectures by men of science, and the publication of results of research which have direct application to the problems of human heredity. The committee will in this way supplement the Committee on Research in Eugenics of the American Genetic Association, and will also, it is hoped, occupy a new field, which has hitherto been left practically unoccupied, but in which there is the possibility of doing a great deal of useful work.

International Eugenics Committee

At the request of the Permanent International Eugenics Committee, whose function is to decide the time and place of each International Congress, and to act in a general deliberative and advisory capacity, President Fairchild of the American Genetic Association has appointed the following members to represent the United States of America: David Starr Jordan, Dr. Frederick Adams Woods, Dr. Rupert Blue, Charles B. Davenport.

Major Leonard Darwin is president of this committee, and Mrs. Gotto honorary secretary. The next meeting is to be held in London August 8. Belgium, Denmark, France, Germany, Italy, Norway and Sweden are represented on it, in addition to England and America.

RETICULAR HEREDITY

Heredity in a Network of Descent—A Conception Based on the Normal Evolutionary Condition of Species—Characters Represent Lines of Descent Rather than Independent Units in Germ-Cells.

O. F. Cook

Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

THE practical value of a scientific theory lies in its use as a method of thinking. Study of the general problems of heredity should enable us to think more clearly regarding the special problems that need to be solved in the interest of agriculture and the racial improvement of mankind. The danger is always that we allow our thinking to be governed by a few facts or by facts drawn from too narrow a field of investigation. Disconnected facts command only a limited interest, but a theory that suggests relations between different kinds of facts often stimulates interest and leads to further discoveries. The utility of a general theory, as well as its probability of truth, is judged by its application to a wide range of facts.

Assumptions or analogies that may appear thoroughly justified by one class of observations or experiment often need to be modified to bring them into agreement with data of other kinds. In this way there may be a gradual attainment of a better point of view, one that facilitates the study of all of the related facts. Yet these inductive methods of biological investigation often appear very indirect in comparison with the well formulated systems of the "exact sciences."

The study of heredity is often narrowed to a search for a "physical basis" or "mechanism of heredity." The morphological conception of plants and animals as made up of different tissues and organs has been carried over into heredity, and has suggested the idea of finding something in the germ-cell to correspond to the characters of the adult. The first investigators looked for a complete model of the next generation in the egg, and many similar hopes of finding mechanism of heredity among the organs of cells have been cherished, all to be abandoned in turn, with the progress of cytological discovery. The sex-chromosome hypothesis, suggested by cytological studies of certain groups of insects, is the most recent of these mechanical theories, but is now challenged by other investigators familiar with the cytology of the same insects. The results of breeding experiments are also at variance with the theory that the sex characters are transmitted in the sex-chromosomes.[1]

MECHANISM STILL HYPOTHETICAL.

If something in the protoplasm of the germ-cell could be shown to stand in a definite causal relation to some feature of the adult organism, we might begin to understand heredity in this physical, mechanical sense. But as yet we have no such basis of observation to warrant the localization of particular characters in particular parts or organs of the germ-cell. Indeed, we have no knowledge of characters except in their external manifestation, as features or differences to which attention may be directed in the study of heredity. Theories of heredity are still useful only as analogies and have to be judged by their consistency with general biological facts and their convenience as methods of thought, in bringing the

[1]Foot, Katharine, and Strobell, E. C. Preliminary Note on the Results of Crossing Two Hemipterous Species with Reference to the Inheritance of an Exclusively Male Character and Its Bearing on Modern Chromosome Theories. Biological Bulletin, 24: 187, 1913.

problems of heredity before the mind.

It is easy to admit in general terms that there must be something in the germ-cells to correspond to what we call characters in adult organisms, but to make this general admission is very different from forming a concrete idea of the hypothetical mechanism of heredity. We may be as sure as ever that organisms are machines, but reiteration of confidence in the general mechanical postulate does not give us increased insight into the machinery. The fact is that we are still without any definite indications of the nature of the unformed, rudimentary characters that are supposed to exist in the germ-cells. The many names that have been given to those hypothetical entities, such as pangen, determinant, id, character-unit, gen, etc., are merely symbols for the unknown quantities of biology. Their only use is for the statement of biological problems. Instead of writing our *x* with a single character as in algebra we use the symbol *gen*, with three letters. A gen is the unknown something that is assumed to represent a latent or unexpressed character; that is, a character as it is supposed to exist in the protoplasm, before it comes into expression during the development of the organism.

MENDELISM A MONOGENIC THEORY.

The so-called Mendelian theory of heredity is in reality a theory of the formation of germ-cells. To the assumption that characters are transmitted as separate particles or discrete entities of some sort, is added the idea that each germ-cell receives and transmits only a single set of these character-bearing "units."

The cells that build up the bodies of plants and animals, the so-called "somatic tissues," are supposed to contain two separate sets of character-units, or gens, derived from the two parental germ-cells that united in conjugation and initiated the development of the new organism. But with each return to the formation of germ-cells the two sets of gens are supposed to be broken up and redistributed in single sets. If the two series of gens derived from the parent germ-cells are alike, all of the new germ-cells have the same series of gens. But if all of the gens of the two parental series were not alike, the new germ-cells receive one or the other of the unlike gens, but not both. Thus the germ-cells of hybrids between different varieties or species are supposed to remain "pure" with respect to the contrasted characters of the parental stocks.

On account of this assumption of "pure germ-cells" Mendelism may be described as a monogenic or single-gen theory of transmission. Only one gen of the kinds required to produce the various features of an adult plant or animal is supposed to be represented in the same germ-cell. The failure of a parental character to reappear in some of the members of the second and later generations of offspring is explained by assuming that the character was transmitted to only half of the germ-cells. The theory does not provide for the transmission of additional gens to represent characters that may not be brought into expression, or that may give rise to unexpected variations in later generations. To explain such variations Mendelian writers resort to the theory of De Vries, that new characters and new species arise by mutations. If a sudden change of characters appears in a member of an otherwise uniform, "pure bred" stock, it is assumed that a new character has been formed, and that such changes in the characters of uniform groups are examples of normal evolutionary progress.

ORIGIN OF NEW GENS.

The effect of these theories is to return to the pre-Darwinian doctrine of special creation, except that the species are not supposed to be made altogether *de novo*, but by implanting the gens of new characters in members of old species. The change of any single character is supposed to establish a new "elementary species" or "biotype." How the new gens are made and substituted for the old ones is not explained, but the mathematical simplicity of the monogenic hypothesis and the idea that the chromosomes or other

internal organs of the germ-cells might represent actual, visible units of heredity, have proved very attractive, and have induced many recent writers to abandon the Darwinian conception of gradual evolutionary progress in natural species. Darwin was familiar with abrupt changes of characters, or sports, as he called them, but he did not consider them new species or examples of normal evolutionary progress. The doctrine of De Vries, supported, as it seemed to be, by the Mendelian theory of heredity, has been hailed as a great advance over Darwinism. But in some respects the new anti-Darwinian theories are logically inconsistent among themselves as well as lacking the support of pertinent facts. The more we emphasize the idea of characters as represented by definite pre-existent entities or gens, the more difficult it becomes to believe that new characters are suddenly implanted.

That workers in other fields of biology have been unable to accept the recent Mendelian and De Vriesian interpretations of the facts of heredity has not seemed a serious matter to those who were fully convinced by the statistical and cytological arguments. From this point of view it seemed a waste of time for "geneticists" to familiarize themselves with the natural species from which Darwin and his successors attempted to learn the nature of evolutionary processes. Indeed some writers have formally dismissed the idea of species as too vague and indefinite for the application of "exact methods." Instead of attempting to understand the development of new characters through the gradual evolutionary progress of species, attention is now given mostly to the changes of characters that appear in artificial pure bred strains under "experimental conditions."

But even this class of variations does not serve to support the monogenic conception of heredity. There is still no adequate proof of the most elementary assumption of the monogenic theories regarding hybrids and mutations, that one gen or character-germ can be taken out and another substituted, and leave the remaining characters the same as before. Mutations and hybrids have not been found to differ from each other by single characters as they are supposed to do in Mendelian and De Vriesian systems.

The fact that mutations commonly differ by many characters, instead of by single characters, was noticed several years ago, and was stated in a discussion of the difference between varieties and natural species[2]. Since that time many additional mutations and hybrids of cotton and other plants have been examined with this question in mind, but thus far without finding a satisfactory instance of monogenic mutation or mutative reversion. In all cases where a definite change in one character was noticed equally definite differences in other characters were found. Such facts indicate that mutative changes should be thought of as polygenic, that is, as affecting several characters at once, instead of assuming that they are commonly or typically monogenic, in the sense of being limited to single characters.

ABNORMAL MENDELIAN PHENOMENA

The nearest approach to monogenic behavior is found in cases of albinism or similar differences that may arise from simple chemical reactions. But certainly these color changes and allied phenomena afford a very narrow margin for the support of the general Mendelian idea of the existence of characters as independent units. Indeed, many Mendelian writers have virtually abandoned this idea of alternative units in adopting the "presence-and-absence" hypothesis to explain the results of Mendelian experiments. But if it be assumed that the Mendelian condition of alternative inheritance is a consequence of the dropping of normal characters out of expression, the Mendelian phenomena lose all constructive evolutionary significance and take their place among admitted abnormalities.[3]

[2]Cook, O. F., Mendelism and other Methods of Descent, Proc. Washington Academy of Sciences, 9: 235. 1907.

[3]Professor Castle has recently utilized this view of Mendelian characters as affording a basis for simplification of the Mendelian notation. See Castle, W. E. Simplification of Mendelian Formulae. Amer. Nat. 47: 170, 1913.

In reality alternative inheritance is not limited to characters that show the Mendelian reactions, but extends into other fields of heredity where the theory of germinal segregation and alternative transmission of unit characters does not apply. The sudden changes of characters often shown in successive internodes of the same plant are as abrupt and as definite as any mutative change or Mendelian alternation, and yet these changes of characters in internodes take place without any opportunities for the segregation and redistribution of gens in the formation of new germ cells, as required by the Mendelian theory of alternative transmission. Such changes of character, occurring during the development of the same individual plant or animal, must represent alternative expression of characters, instead of alternative transmission. And after this distinction is appreciated it appears reasonable to expect that other sudden changes or abrupt differences among the individuals of the same stock may represent variations in the expression of characters, rather than differences of transmission. Changes of expression must be considered in the study of heredity, as well as differences of transmission.[4]

THE POLYGENIC INTREPRETATION.

Instead of a single set of gens, as assumed in the theory of Mendelism, a multiple transmission of many alternative gens should be recognized, enough to represent the whole range of ancestral diversities. When the variations of domesticated stocks are compared with the diversities of related wild types the same general range of character is found. Many of the so-called "new characters" of mutative variations should be considered rather as suppressions or reappearances of old characters. The phenomena of reversion and recapitulation indicate that the transmission of characters is entirely independent of expression, and that characters may be transmitted in latent form for many generations and still retain their power of returning to visible expression.[5]

A polygenic interpretation of heredity does not conflict with the facts of Mendelism and mutation, and is in better accord with other facts of biology, both evolutionary and physiological. From a polygenic viewpoint, mutations and Mendelism appear as differences in the expression of the characters, rather than as differences of transmission. The mathematical formulae of Mendelism apply as readily to the expression of characters as to transmission and the polygenic conception of heredity enables us to avoid the misleading inferences that have been drawn from the monogenic theories. It no longer appears necessary to believe that the degenerate mutations of domesticated plants and animals represent new species, or even new characters. Uniformity in the expression of characters no longer appears to be the normal condition of heredity or of evolutionary progress. On the basis of a polygenic theory the typical condition of heredity, as of evolutionary progress, is found in normally diverse, freely interbreeding wild species, instead of in narrow-bred or self-fertilized domesticated varieties. The production of groups of uniform individuals by selective breeding or by special methods of propagation does not eliminate characters from transmission, but only regulates the expression of characters. It remains possible for the characters of remote ancestors to reappear in reversive mutations.

That characters should be transmitted in a latent condition may seem too wonderful for belief, but the fact remains that all characters are transmitted in a latent condition. The germ-cells, eggs, embryos, larvae and juvenile states do not have the characters of adults, except in the sense of transmission, nor do adults have the characters of the preliminary stages, except in the same sense of transmission to their offspring. It need not

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[4]Cook, O. F., "Dimorphic Leaves of Cotton and Allied Plants in Relation to Heredity," Bulletin 221, Bureau of Plant Industry, U. S. Department of Agriculture, 1911.

[5]Cook, O. F., "Transmission Inheritance Distinct from Expression Inheritance," Science, n.s., vol. XXV, June 7, 1907. p. 911.

be considered more strange that a character should continue latent for a series of generations than that a seed should lie dormant for a period of years, expressing none of the characters of the plant, and yet losing none of them.

What we call characters may be, after all, only phases or stages in the development of the organism and may not be embodied in the protoplasm in any such manner as the corpuscular or genic theories have assumed. The larva or the embryo, the egg or the spermatozoon, is as truly an organism as the adult. Each form of life has its complete cycle and it is only an artificial, mechanical analogy that leads us to think of one part of the life-cycle as less complete than another. The cycle being continuous, each part can be considered as a preparation for the next, but in the very nature of the case there is no beginning or end.

If the idea of transmission seems to involve the notion of embodiment of the characters in the protoplasm of the germ-cells, we should see that this is only a deduction from the preconceptions with which we have approached the subject, and that it affords us no additional insight into the process of transmission. Until we have a working knowledge of the constitution of the protoplasm itself, the nature of the process of transmission can only be inferred from the facts of expression. Any inferences that may be drawn regarding the numbers and relations of the gens must accord with the behavior of the visible characters, and must accommodate the facts of heredity in networks of interbreeding lines of descent in natural species, as well as in single lines of descent in specially propagated domesticated varieties.

Domestication has been supposed to change the characters of plants and animals by placing them under different environmental conditions, but this factor is probably much less important than changes in the methods of descent. Where domestication has not been accompanied by restriction of descent, the normal state of individual diversity has not been lost, or given place to the greater diversity between narrow bred strains. In such cases as the rye plant or the Guinea fowl, where narrow breeding has not been practiced, the whole species remains relatively uniform and stable, in comparison with the species where descent has been restricted to narrow groups or to individual lines.

COHERENCE OF CHARACTERS.

Merely increasing the numbers of gens does not fully provide for the fact that many characters are usually changed together instead of one character at a time. Even assuming that there are many alternatives for each of the features of a plant or animal, there would still be no reason why the substitution of one of these alternatives for another should be connected with changes among the alternative gens of other characters. Our ideas of relations of the gens to each other have to be modified, in addition to recognizing increased numbers of gens. If we think of characters as representing stages and alternative courses of development, the gens, as predetermining rudiments of the characters, must be thought of as having intimate mutual relations, instead of being considered as entirely independent.

The tendency of characters to segregate or behave as independent entities, as manifested in typical Mendelian hybrids, is often counteracted by an opposite tendency to coherence or associated expression of characters. When the tendency to coherence is strong a whole series of characters may behave more or less like a single Mendelian unit, so that examples of coherence are often reported as cases of Mendelism.[6]

It may be nearer the truth to say that organisms different in one respect are different throughout, than to make the Mendelian or monogenic assumption that characters are separate entities to the extent that one character can be changed without affecting the others. The idea of alternative courses of development is in better accord with the general facts of biology than the idea of alternative gens, as shown by the

[6]Cook, O. F., Mendelism and Interspecific Hybrids, American Naturalist.

nature of individual differences among the members of normally diverse species, with free intercrossing of different lines of descent. We are familiar with diversity in the human species, and do not expect to find two individuals with exactly the same characters, except in cases of identical twins, and here the phenomenon of uniformity is ascribed to a division of the fertilized egg cell, analogous to vegetative propagation. As far as observation has gone, a similar diversity exists everywhere in nature, except where it is restricted by special methods of reproduction. To fit the facts of nature our theories must provide enough gens and in sufficiently intimate relations with each other to equip this infinite diversity of individual forms.

CHARACTERS AND LINES OF DESCENT.

Instead of trying to think of gens as separate entities or corpuscles of any sort we may think of them as parts of the ancestral lines that form the network of descent of the species. A better idea of the nature of the germ-plasm may be gained by considering it as a part of this network of descent. The cells that make up the bodies of plants or animals are connected into networks by delicate threads that pass through the cell walls, and the protoplasm inside the cells also has a reticular structure. Thus there is no lack of analogy for assuming a relation between characters and lines of descent. Indeed, we have all the phenomena of sexuality to warrant the suggestion of a physiological or causal relation between the network of the species and the network of the cell. As the crossing of lines of descent undoubtedly has a physiological function in increasing and maintaining the efficiency of the protoplasm, those who dwell on the idea of a mechanical basis for the phenomena of life should be the more ready to look upon the reticulum of the cell as representing the network of descent of the species. This relation or analogy allows us to consider the expression of each character as marking a stage in the development of the individual, and at the same time as corresponding to one of the many ancestral lines or alternative courses of development that are open to the members of a diverse species propagating itself in a normal network of descent.

Selective line breeding, self-fertilization, or vegetative propagation, enable us to establish definite courses through the maze of alternative paths of expression. When regularity of expression has been secured, so that all the members of a stock bring the same characters into expression, we have a uniform "pure" race. Uniformity has been accepted in the monogenic theory of Mendelism as representing the normal condition of heredity, though breeders know that uniformity is generally artificial, as well as temporary. Even in the most carefully selected stocks mutations continue to appear, the "sports," "rogues" or "black sheep" that are rejected because they do not follow the standard course of development. Thus the breeder's care is required to maintain the uniformity of a select stock, no less than to originate it in the first place.

The analogy between characters and lines of descent also allows us to think of successive appearances of the characters in the development of the individual as corresponding to their successive development in the evolutionary progress of the species. It is not necessary to suppose that the embryological record is entirely consistent or complete. New specializations, such as the larval characters of insects, may be intercalated into the early stages of the life history, instead of being added at the end. The extreme form of the recapitulation theory, that the embryonic and juvenile characters represent the exact courses of evolutionary progress, has been abandoned, but this need not interfere with the recognition of a general analogy or parallel between evolutionary development, or transmission of characters, and individual development, or expression of characters. Each character may still be thought of as a stage of development, reached by following one of the ancestral courses or lines of descent.

The conception of characters gained by this analogy is more concrete and

stands in a more effective relation with general ideas of evolution and heredity than any of the character-concepts that have been based on the wholly hypothetical "units." There is no objection, of course, to particularizing the characters in any way that the facts warrant, or to recognizing any ascertained relations to chemical substances or to physical conditions, but all this can be done without abandoning the general idea of multiple descent and multiple transmission of alternative ancestral characters.

CONCLUSIONS.

The Mendelian theory of heredity may be described as monogenic because it assumes the transmission of only one set of gens or character-units in each germ-cell. A polygenic theory is required to account for the fact that latent or suppressed characters are transmitted, as well as those that are brought into expression. The polygenic nature of heredity is also indicated by the fact that mutative changes of expression usually affect many characters at once, instead of single characters. A further advantage of the polygenic conception is that it allows characters to be brought into analogy with ancestral lines that form the network of descent of the species.

The assumption that characters are pre-existent in the protoplasm of germ-cells as discrete particles or independent units of any sort is not justified by observation or by logical necessity. Equally convenient and more truly biological methods of thinking about the problems of heredity can be developed by recognizing the relation of heredity to the network of descent of the species. This conception allows characters to be thought of as representing lines of descent instead of as discrete particles in the protoplasm.

Value of a Knowledge of Heredity

It seems to me that no kind of study can be made to bear intellectual fruit of nearly such value as the study of heredity. It lies at the root of every science and every study connected with life from botany and zoology to medicine, sociology or pedagogy. Who knows it not knows not life except in its superficial aspects. He may be a student of philosophy or a worker in biological science, but in these days when heredity enters so much into philosophy and links together so many biological sciences, he cannot be a very effective thinker or worker. It furnishes a master-key to the more tremendous events of history, and is our only hope against disasters that loom great and terrible in the near future. It goes deep down to the springs of human life, and thought, and conduct, and explains why some nations are inheriting the earth and the fruits thereof, while others are dying physically or mentally. The philanthropist must know something of this science or he will grope in the dark. The statesman must know something of it or he may labor in vain. Transcending all else in importance is the educational value of heredity. No nation in which a knowledge of it was widespread could possibly be stupid or brutal. The habits of thought which must be brought to its study are exactly those which counteract best the tendencies which have plunged so many nations into their Dark Ages. So few are the essential facts of heredity, but so prolonged, close and accurate must be the reasoning founded on them, that no great strain is placed on the memory while the reflective faculties are exercised in the highest degree. So largely would the student's learning link up with the subsequent experiences of his whole life that little would be forgotten, and a sure foundation would be laid for a clear and wide intellectual outlook.—G. Archdall Reid: The Principles of Heredity (1904).

INHERITANCE IN PLANT HAIRS

Stinging Bristles of Wild Plant—Black Tomentum of Velvet Bean—Fine Down of Lyon and China Beans—Coarse Down of Yokohama Bean—Stinging Bristles of Hybrids—Nine-Sixteenths of the Second Generation Stinging—Three-Sixteenths of the Second Generation with Black Tomentum on Plants and Pods—Fine, Coarse, and Intermediate Downy Pods—"Velvet" Plants—The Third Generation—Working Hypothesis.

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MUCH useful information has been gained by experiments on the inheritance of the color, length, and texture of hair, fur, or wool, in animals. Opportunities for similar experiments with plants have been rare. But in the second generation of crosses between the Florida Velvet bean and another species of Stizolobium[1], the Lyon bean, seven distinct forms of bristles, tomentum, and down cover the pods or other parts of the different plants; while the color of these plant-hairs varies between red, yellow, gray, white, brown, and black. Since each plant requires 64 square feet, there is no inducement to grow families solely for the study of the inheritance of the different kinds of pubescence. However, in raising improved constant races from the offspring of these crosses, considerable attention had to be given to the inheritance of the covering of the pods, and some of the main genetic differences have been disclosed. As several members of the American Genetic Association are investigating these plants, the following short account of my results may perhaps lead others to fill up gaps in our knowledge which I have been unable to fill as yet, although during each of the past four years the length of the rows of pedigreed plants I have grown amounted to about two miles.

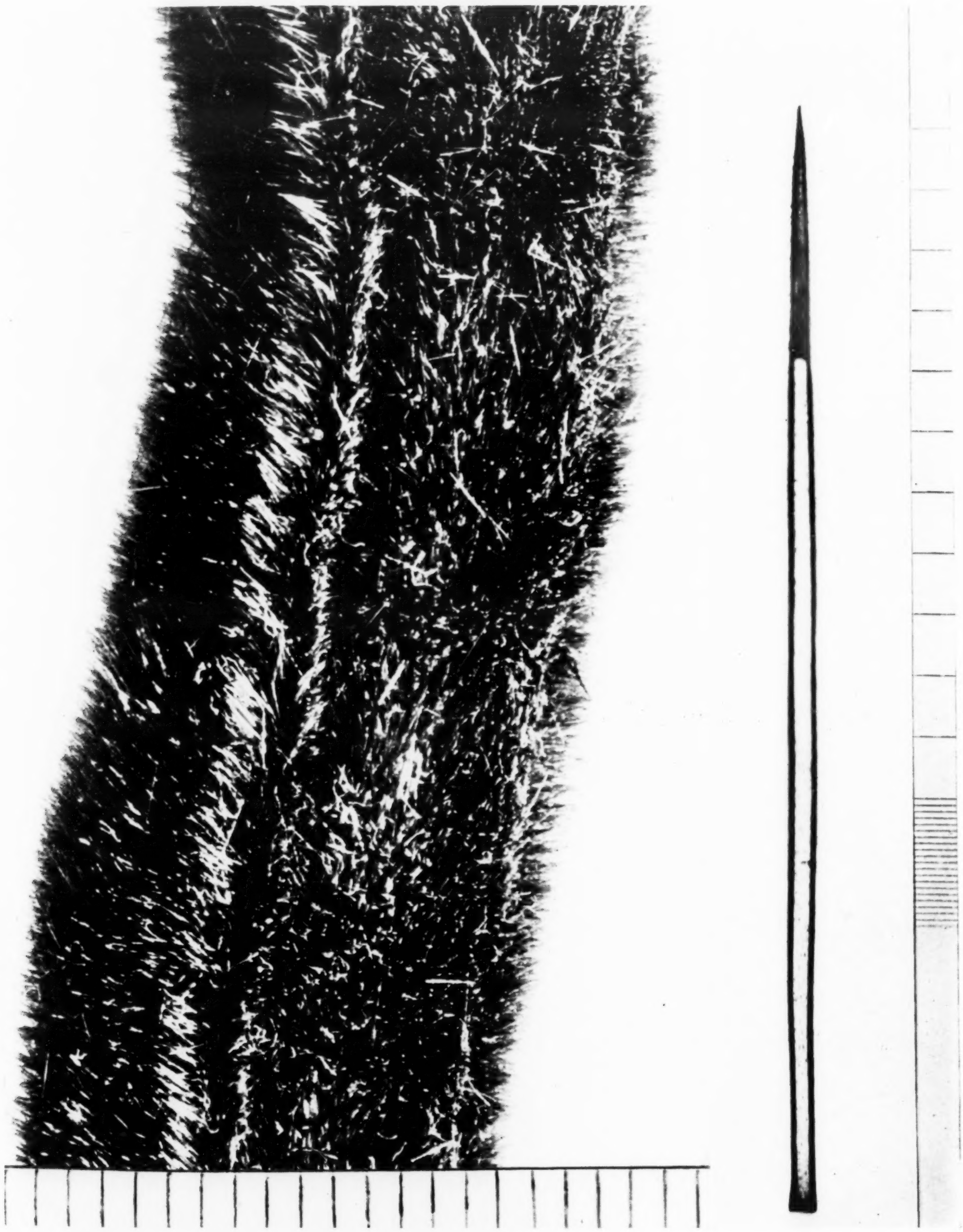
WILD STINGING PODS

A wild Stizolobium from India (*S. pruritum*) has its pods covered with red and yellow erect bristles less than two millimeters long. Part of a pod is magnified in Fig. 7. The bristles readily come loose. Each has its tip filled with a gummy substance, clearly visible in Fig. 7. The tip of the bristle is photographed on the left of Fig. 14. Minute projections like barbs may be seen. These projections form small colorless knobs over most of the bristle, but are longer and pointed near the tip. The two most conspicuous novelties resulting from the crosses were stinging bristles like those of this wild plant, and smooth black pods. These are shown, together with the pods of two parents, in Fig. 8.

THE PARENT PLANTS

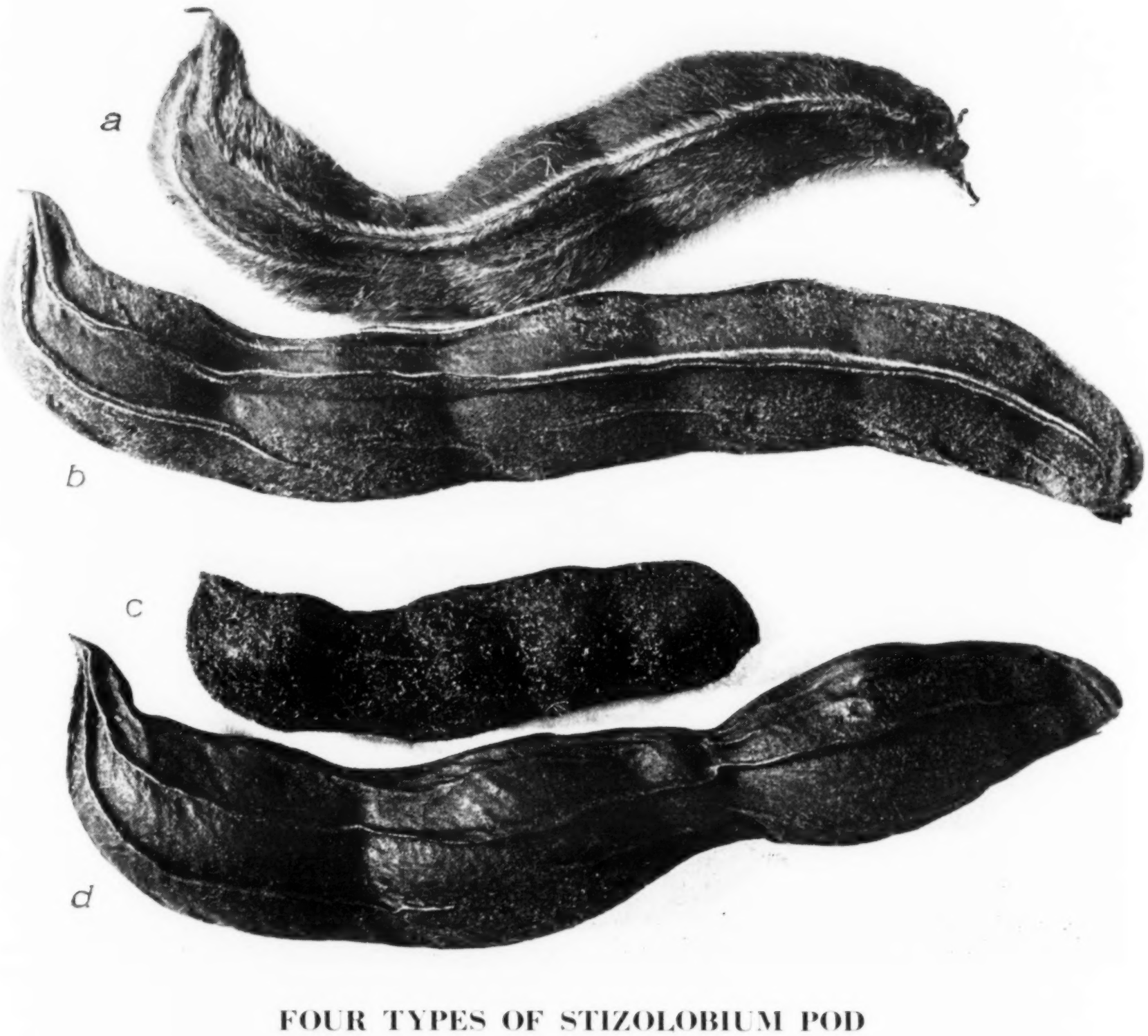
The Velvet bean (Fig. 8*c*) gets its name from the nearly erect, black, silky hairs of its young pods. Its ripe pods are covered with a brownish-black tomentum or wool (Fig. 9, left), the flat twisted hairs of which are often over a millimeter long. One of these hairs is shown in the fifth place in Fig. 15. The fresh tomentum from a nearly full-grown pod is photographed in Fig. 11. Some of the hairs are straight and colorless, as are often the tips of the others. They have minute knobs, and also a little gum within the points. Men picking or threshing Velvet beans often experience irritation caused by the tomentum. If a genetic factor to stiffen and lengthen these weak hairs could be added, they would become genuine stinging bristles.

[1]These are described in Bul. 179 of the Bureau of Plant Industry, by C. V. Piper and S. M. Tracy.



STINGING POD AND BRISTLE

Magnified view, with millimeter scale, of part of the pod of *Stizolobium pruritum*, from India. The closely set stinging bristles are nearly erect. This pod was eight centimeters long. At the right is a photograph of a single stinging bristle from the pod shown, with scale in tenths and hundredths of a millimeter. The gummy substance in the tip is conspicuous. The minute dots seen, especially toward the base, are the colorless knobs referred to in the text. This bristle was reddish-yellow. (Fig. 7.)



FOUR TYPES OF STIZOLOBIUM POD

(b) is the China bean, whose fine down can be seen on the ridge along the center. (a) is from the first generation hybrid of Velvet by China, and is covered with stinging bristles, which are also best seen along the median ridge. (c) is the Velvet bean, covered by white-tipped, dark tomentum, while (d) represents the plants with fine black tomentum, which appear in the second generation and are called by the writer "smooth black." These pods seem glabrous to the eye, but the tomentum can be seen on young pods and (with a lens) in sheltered angles of the dry pods. This particular pod (d) came from a fourth generation plant. Photographs natural size. (Fig. 8.)

The blackish hull of the Lyon bean is made gray by an abundance of fine whitish appressed downy hairs, the longest of which are but little more than half a millimeter. A part of a pod is magnified in the center of Fig. 9. A single hair is seen in the second place in Fig. 15, and some of the fresh down from a nearly full-grown pod is photographed in Fig. 12. Even on these fine hairs minute knobs may be seen with the microscope, as well as a little gummy substance within the sharp tip. The down of the China bean resembles that of the Lyon, but is a trifle longer. Part of a China pod is magnified on the left of Fig. 10, and a single hair is shown in the third place in Fig. 15. The Yokohama bean has longer and silkier appressed down, which is usually yellower, but is otherwise similar. A part of a Yokohama pod is shown magnified on the right of Fig. 9, and a single hair of about the maximum length is photographed in the fourth place in Fig. 15.

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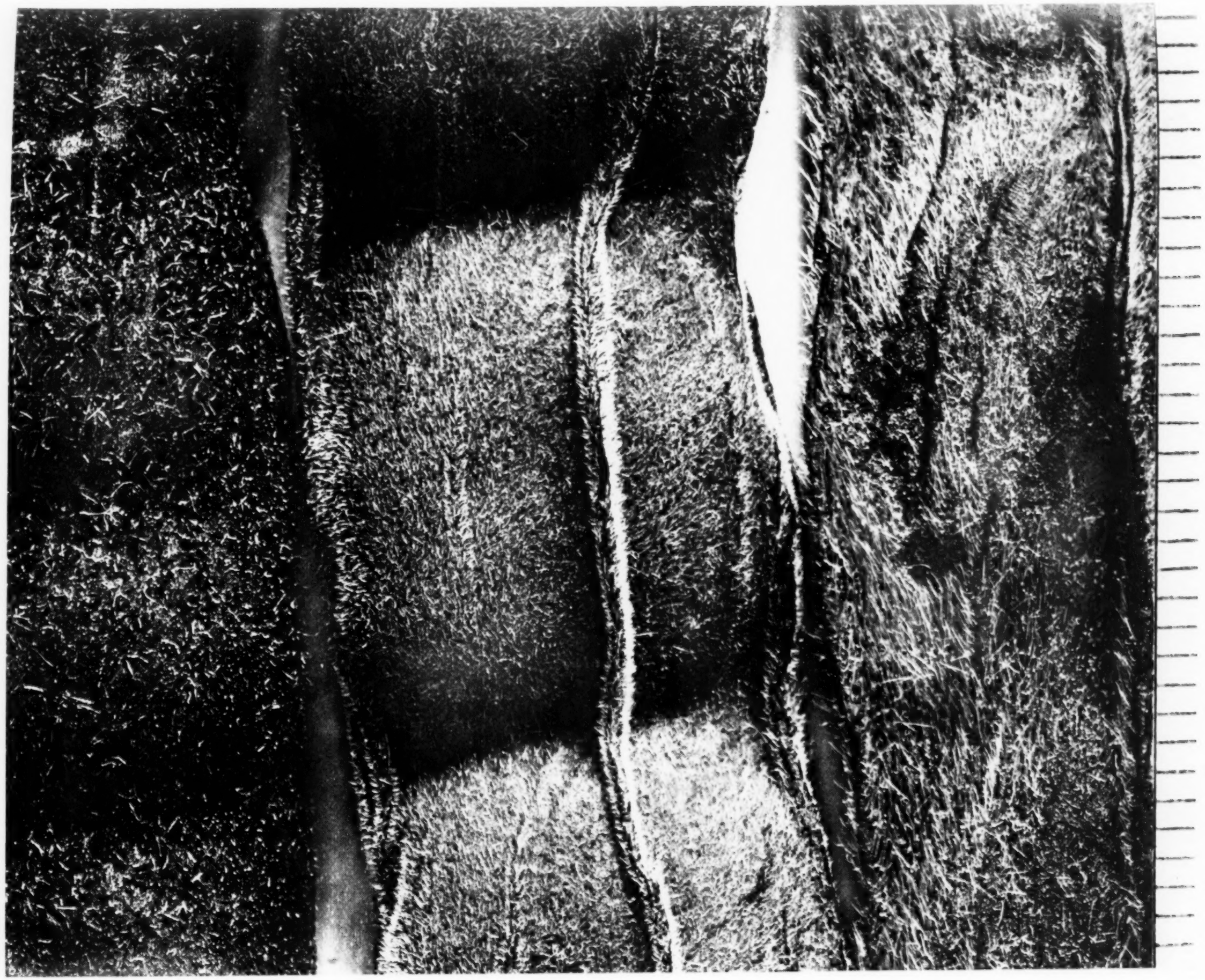

FINE DOWN, COARSE DOWN AND LONG TOMENTUM

The Lyon bean in the center shows fine down, the Yokohama pod to the right has coarse down, and the Velvet bean pod on the left has long tomentum. Scale in millimeters. (Fig. 9.)

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shown in Fig. 8*a*. I am unable to distinguish the bristles from the three hybrids, even with the microscope. They are photographed, together with one from *S. pruritum*, in Fig. 14. These bristles are about one and a half millimeters long. The bristles of the first generation hybrids are shorter and thinner than those of *S. pruritum* and have less gum in the tip. They also sting less. A part of a pod from a first-generation plant of the Velvet by China cross is depicted on the right of Fig. 10. One of the bristles from this pod is photographed on the left of Fig. 15, its tip is shown on the right of Fig. 14, and a number of bristles are shown in Fig. 13. When, after the first frost in the fall, young stinging pods dry up, their pubescence becomes black, flattened, and more or less twisted, much like that of the Velvet bean.

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The chief types of plant-hair appearing in the second generation are shown in Fig. 15. They are:

(1) stinging bristles, about one and a half millimeters, or more;

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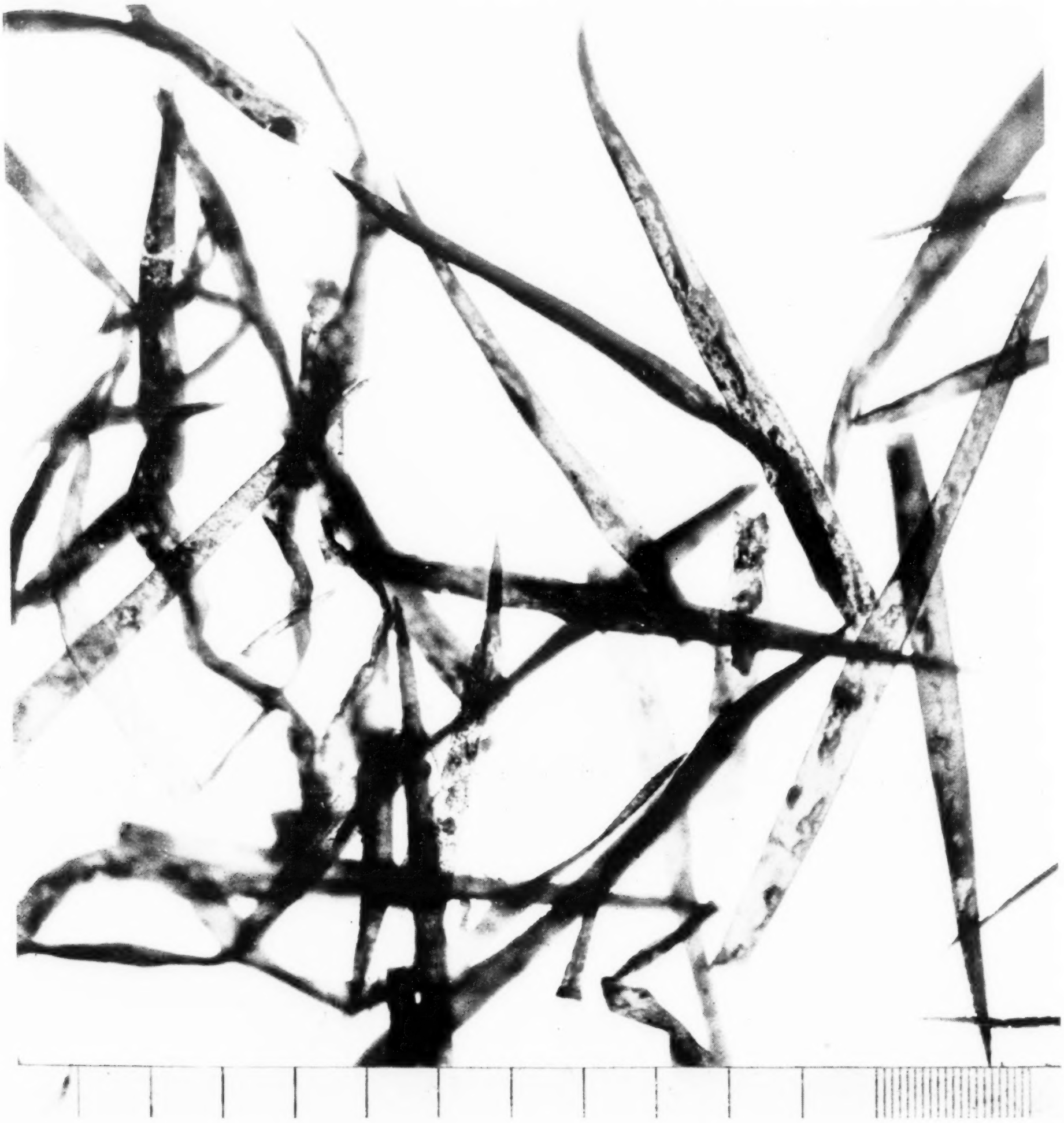

TOMENTUM OF VELVET BEAN

The fresh tomentum from a nearly full-grown pod of Velvet bean. Only a few of the hairs have become twisted. Mounted in water; scale in tenths and hundredths of a millimeter. (Fig. 11.)

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(In the Velvet-Yokohama cross there were no *fine* downy pods.)

Some of the stinging plants had stouter bristles, some had stripes of red bristles on their pods like the wild *S. pruritum*, some had more erect bristles, and a few had sparse bristles. The color varied from yellow to gray, usually with a patch of red bristles at the base of the pod. Some few stung more severely than the first-generation hybrids.

Among the downy plants, the fine downy were greatly in the majority (except in the Velvet-Yokohama cross), but they graded into the coarse downy. Measurements of the hairs of nearly 300 plants under the microscope showed

INHERITANCE IN PLANT HAIRS

Stinging Bristles of Wild Plant—Black Tomentum of Velvet Bean—Fine Down of Lyon and China Beans—Coarse Down of Yokohama Bean—Stinging Bristles of Hybrids—Nine-Sixteenths of the Second Generation Stinging—Three-Sixteenths of the Second Generation with Black Tomentum on Plants and Pods—Fine, Coarse, and Intermediate Downy Pods—"Velvet" Plants—The Third Generation—Working Hypothesis.

JOHN BELLING,
Florida Agricultural Experiment Station, Gainesville, Florida

MUCH useful information has been gained by experiments on the inheritance of the color, length, and texture of hair, fur, or wool, in animals. Opportunities for similar experiments with plants have been rare. But in the second generation of crosses between the Florida Velvet bean and another species of Stizolobium[1], the Lyon bean, seven distinct forms of bristles, tomentum, and down cover the pods or other parts of the different plants; while the color of these plant-hairs varies between red, yellow, gray, white, brown, and black. Since each plant requires 64 square feet, there is no inducement to grow families solely for the study of the inheritance of the different kinds of pubescence. However, in raising improved constant races from the offspring of these crosses, considerable attention had to be given to the inheritance of the covering of the pods, and some of the main genetic differences have been disclosed. As several members of the American Genetic Association are investigating these plants, the following short account of my results may perhaps lead others to fill up gaps in our knowledge which I have been unable to fill as yet, although during each of the past four years the length of the rows of pedigreed plants I have grown amounted to about two miles.

WILD STINGING PODS

A wild Stizolobium from India (*S. pruritum*) has its pods covered with red and yellow erect bristles less than two millimeters long. Part of a pod is magnified in Fig. 7. The bristles readily come loose. Each has its tip filled with a gummy substance, clearly visible in Fig. 7. The tip of the bristle is photographed on the left of Fig. 14. Minute projections like barbs may be seen. These projections form small colorless knobs over most of the bristle, but are longer and pointed near the tip. The two most conspicuous novelties resulting from the crosses were stinging bristles like those of this wild plant, and smooth black pods. These are shown, together with the pods of two parents, in Fig. 8.

THE PARENT PLANTS

The Velvet bean (Fig. 8*c*) gets its name from the nearly erect, black, silky hairs of its young pods. Its ripe pods are covered with a brownish-black tomentum or wool (Fig. 9, left), the flat twisted hairs of which are often over a millimeter long. One of these hairs is shown in the fifth place in Fig. 15. The fresh tomentum from a nearly full-grown pod is photographed in Fig. 11. Some of the hairs are straight and colorless, as are often the tips of the others. They have minute knobs, and also a little gum within the points. Men picking or threshing Velvet beans often experience irritation caused by the tomentum. If a genetic factor to stiffen and lengthen these weak hairs could be added, they would become genuine stinging bristles.

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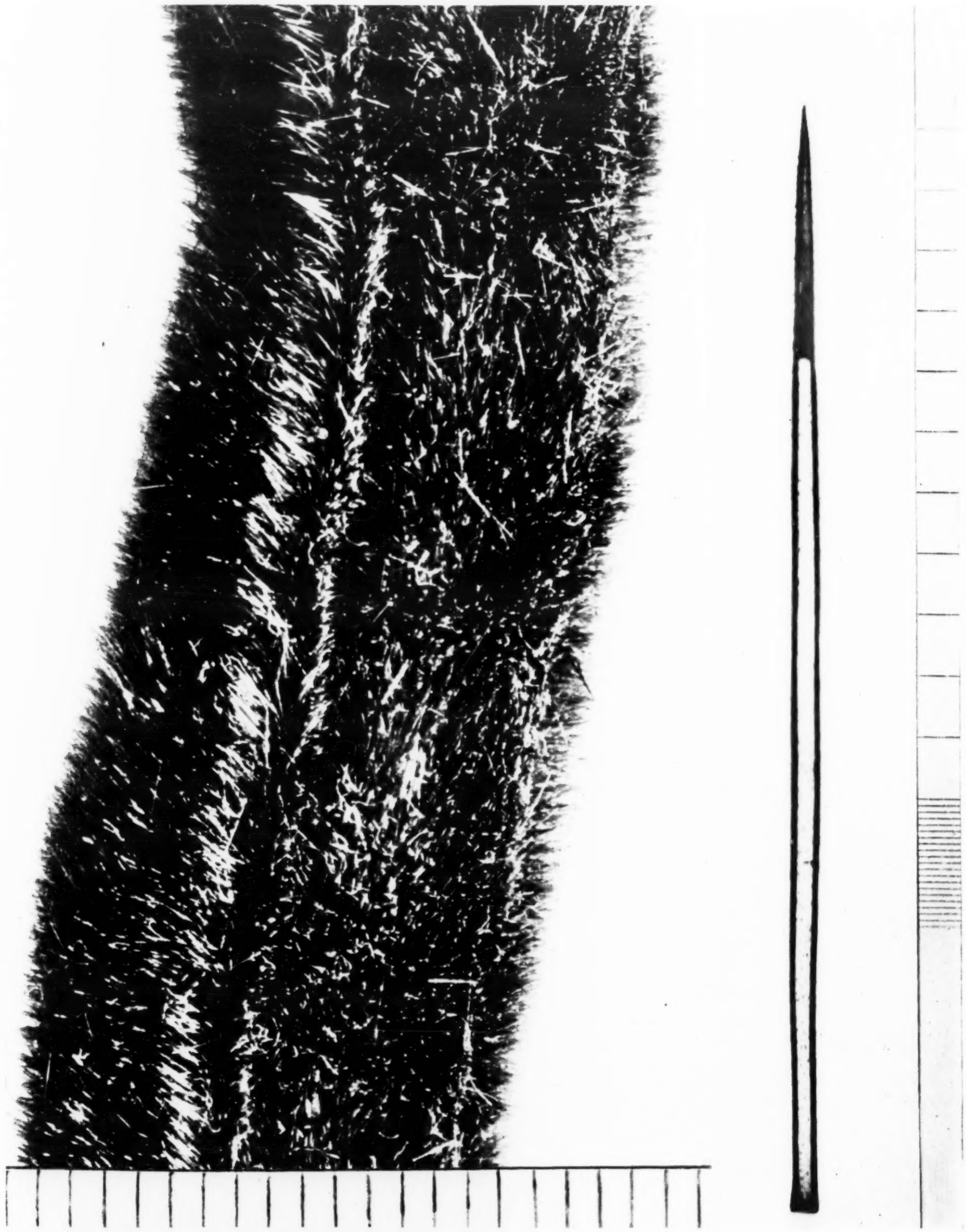

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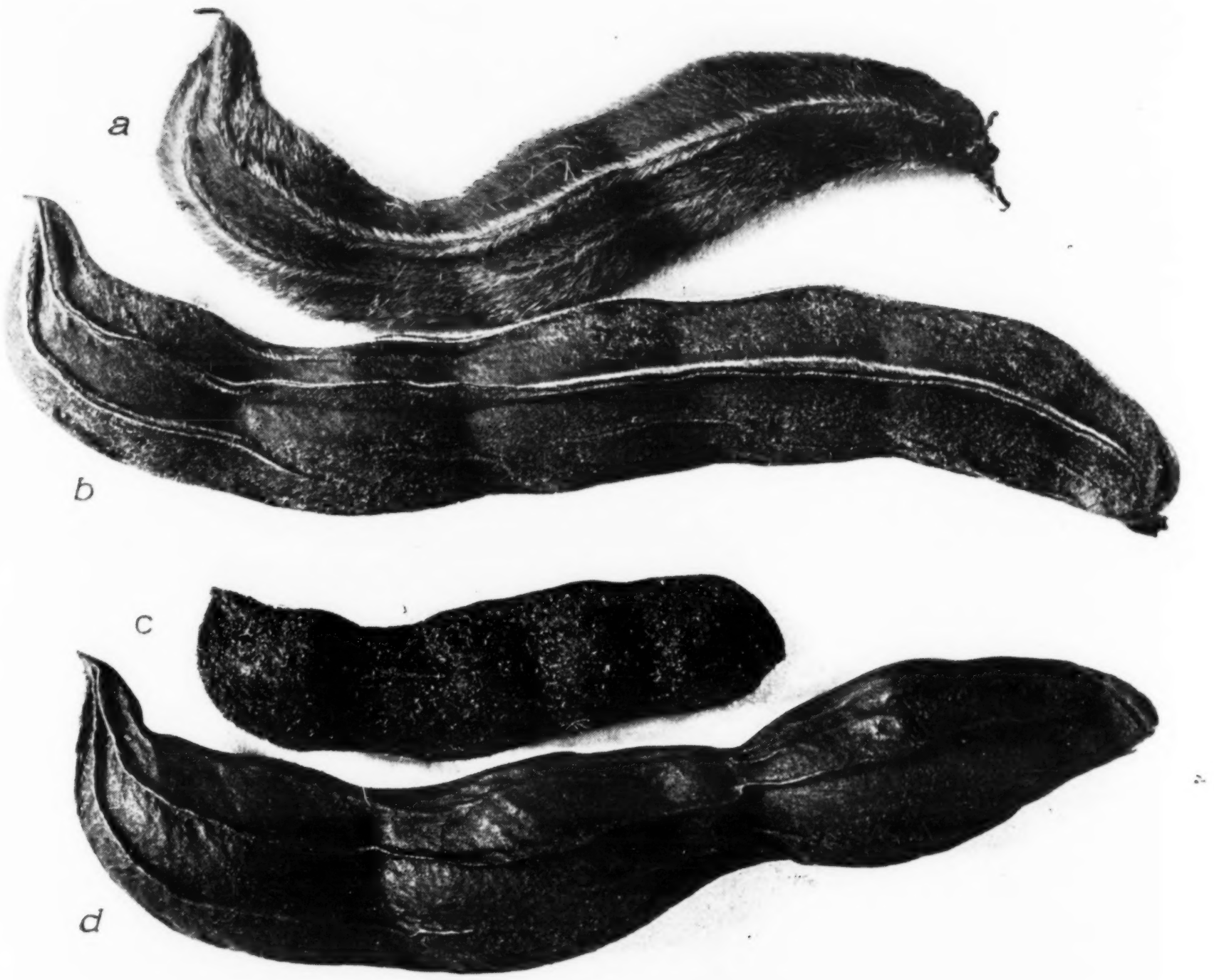

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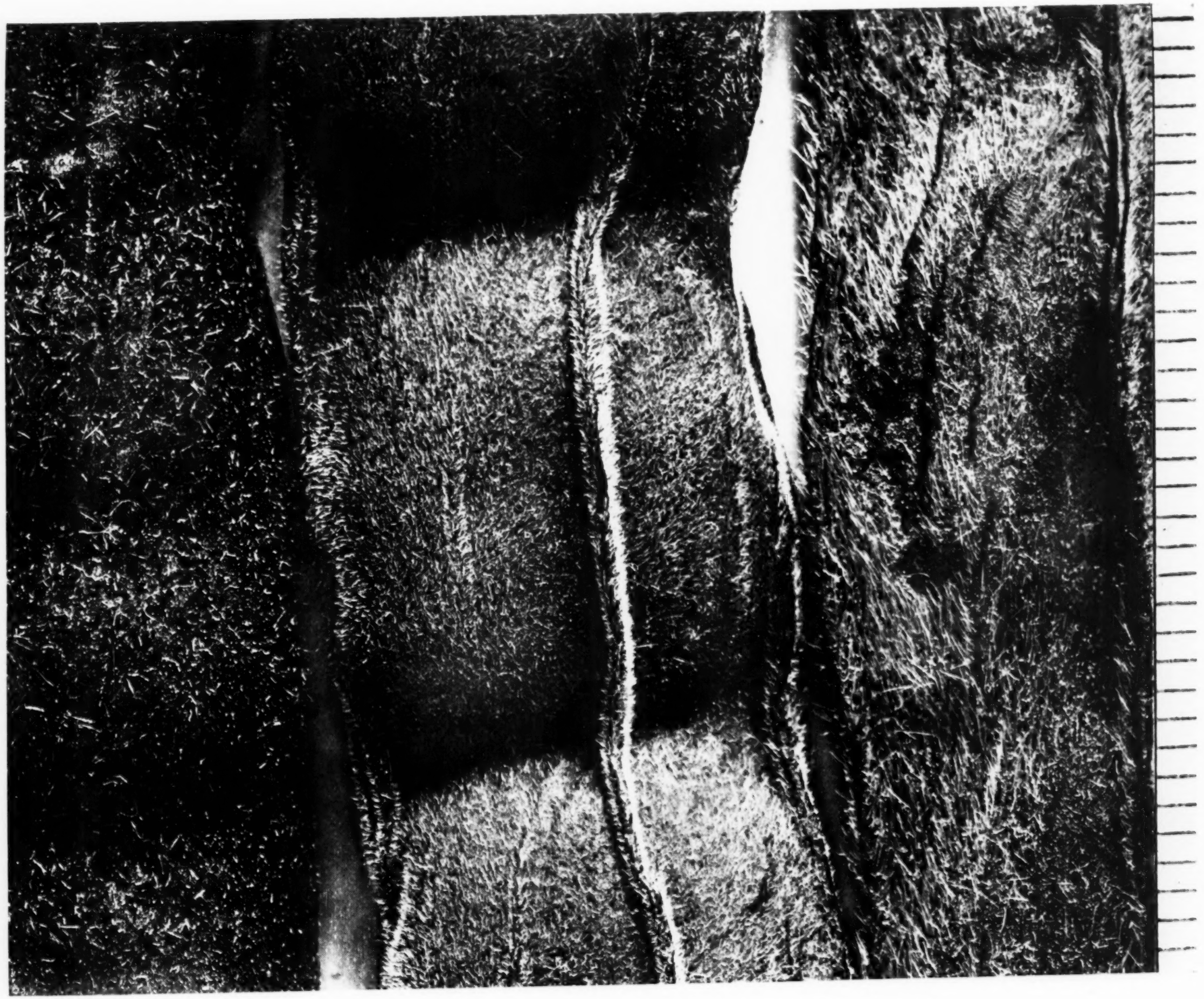

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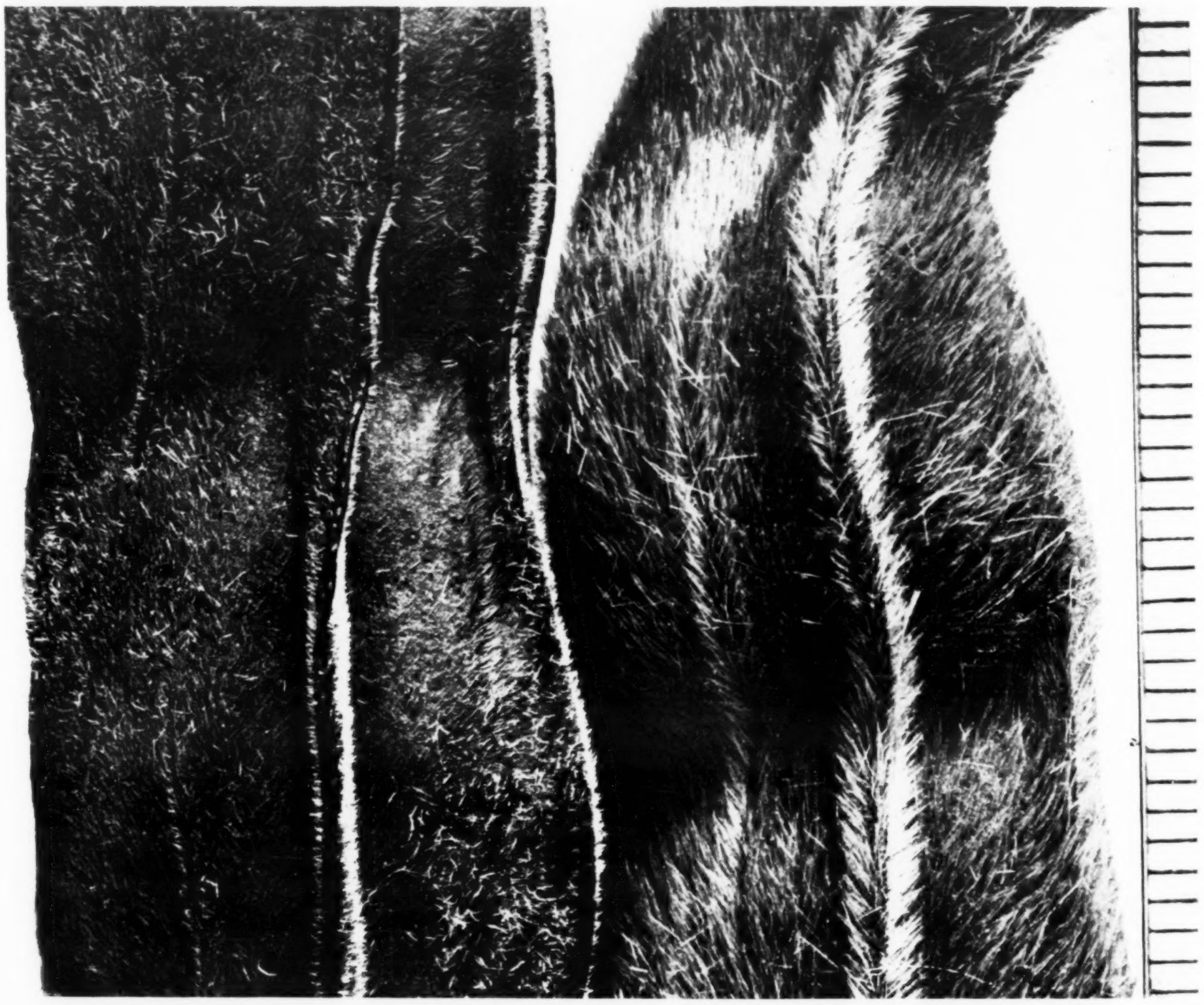

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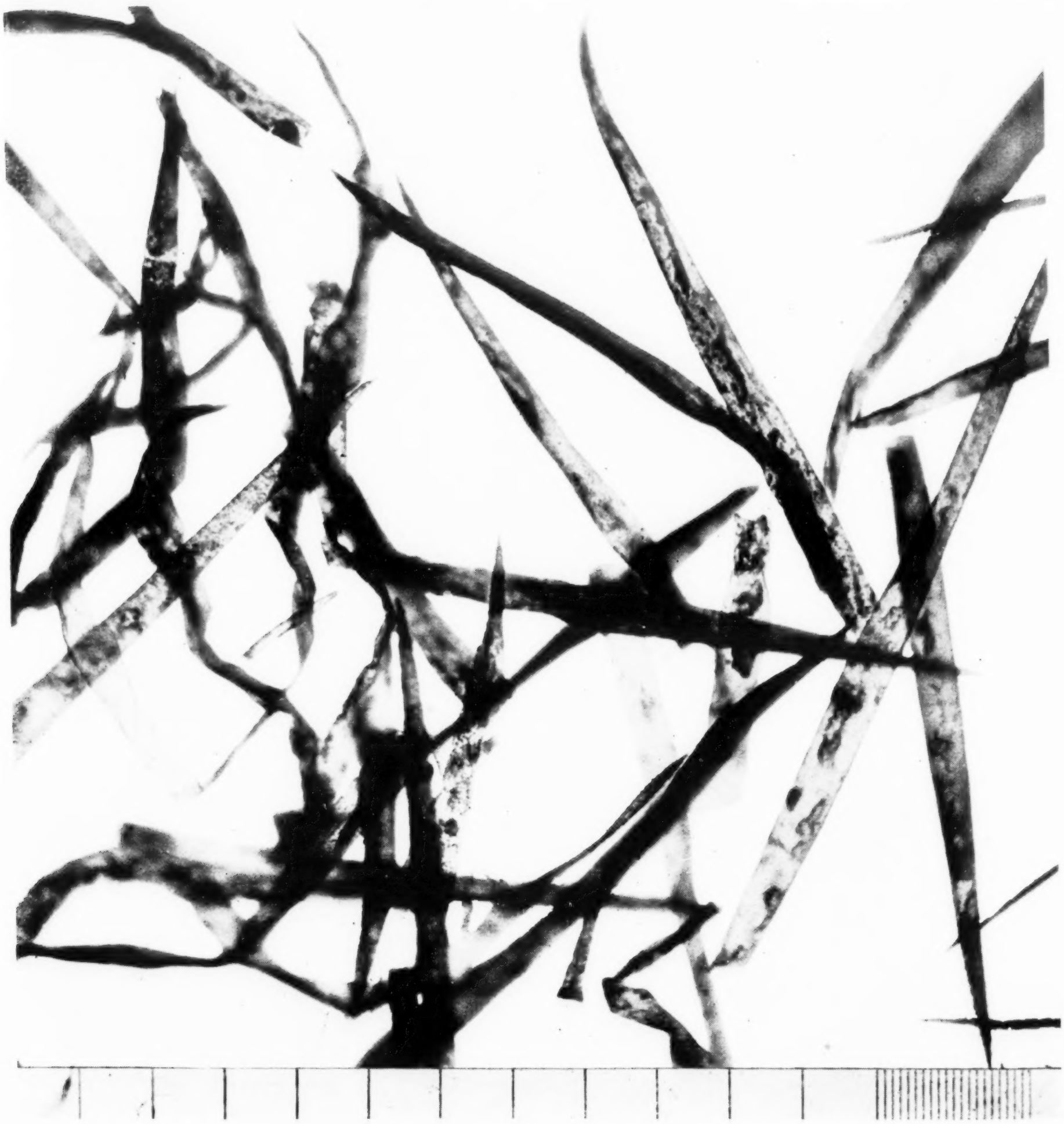

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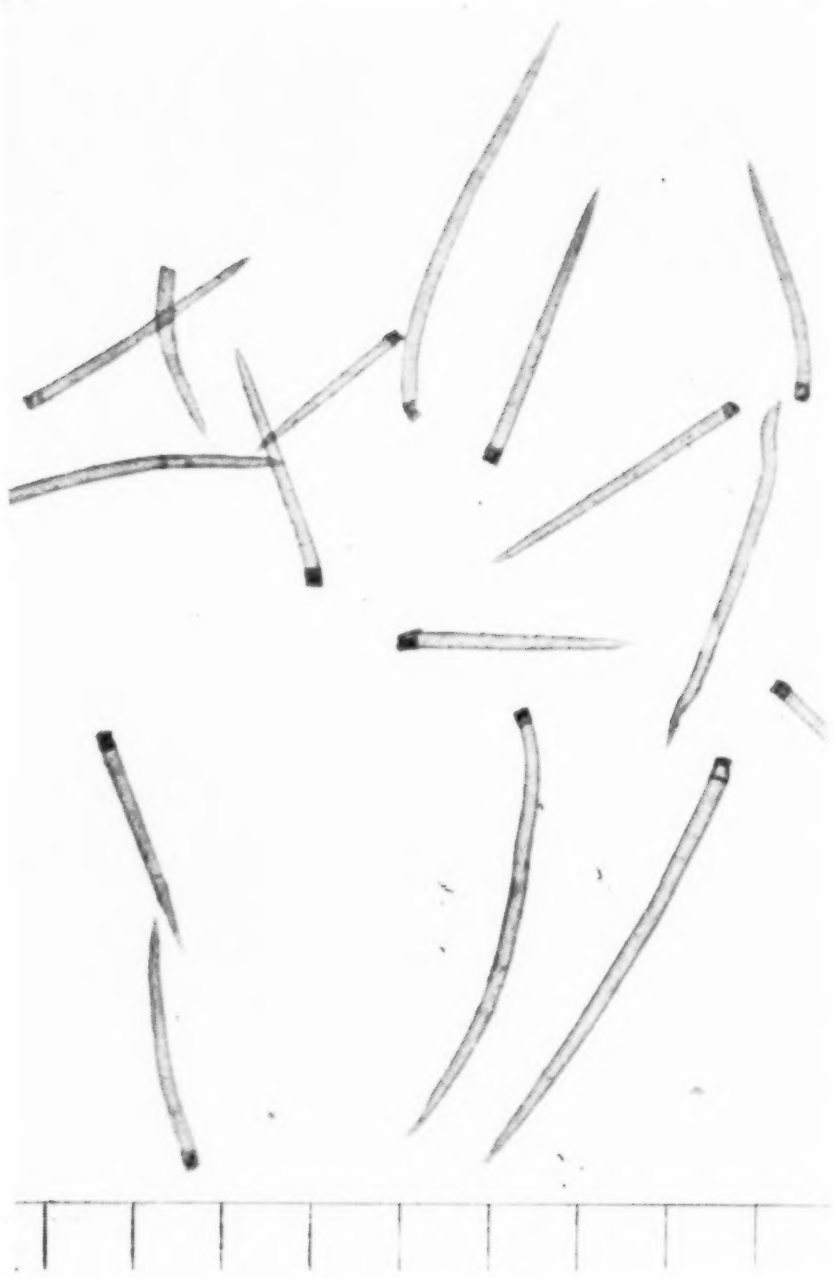


DOWN OF LYON BEAN

The fresh down from a nearly full-grown pod of Lyon bean, mounted in water. A short basal cell in most cases accompanies the unicellular hair. Scale in tenths of a millimeter. (Fig. 12.)

had black tomentum mixed with the white pubescence on their young shoots. The color varied from grayish brown to brownish-black.

The black plants with long tomentum (long black) had sometimes tomentum on their pods almost as rough as that of the Velvet bean, but it was usually softer and blacker. It was sometimes sparse.

The black plants with short tomentum (smooth black) usually lost most of it from their ripe pods, so that they appeared glabrous and coal-black. In a few cases the tomentum was lighter brown.

Since more than half of the black plants set no pods, the ratio of long black to smooth black cannot be determined. Rather more than three times as many long black plants set pods in the three crosses, but the smooth black were distinctly later and more abnormal. Hence it is possible that the ratio is 2:1. The segregation appears in Table A.

In the first cross so many plants with white pubescence set no pods that the proportions are rendered unreliable. From the close agreement of the other two crosses with the calculated most probable numbers, we may be sure that the proportions are:

Stinging.		Downy.		"Velvet."		Black.
9	:	3	:	1	:	3

TABLE A

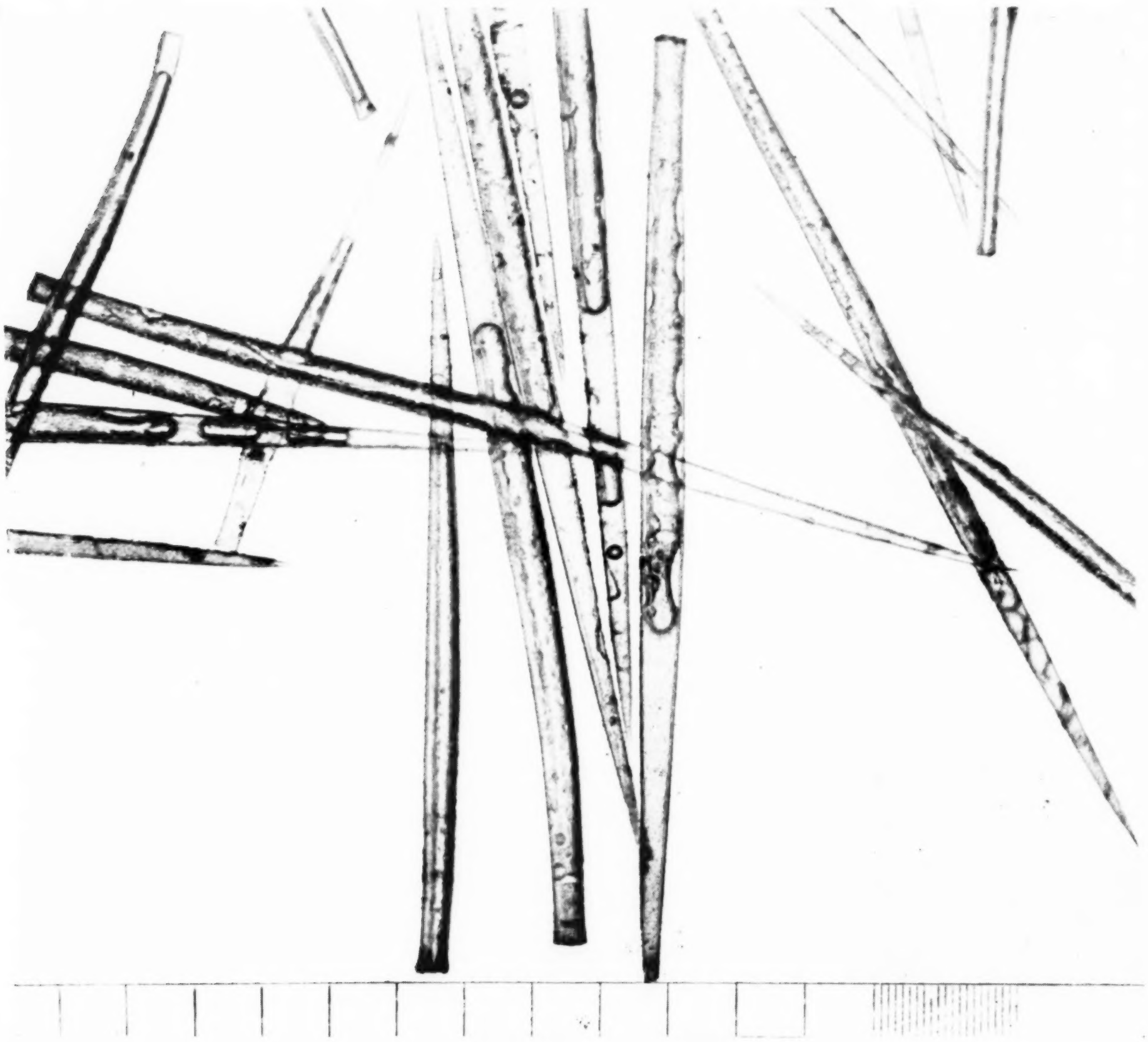
	White Shoots			Black Shoots.	White; *set no pods.*	Number of plants.
	Stinging.	Downy.	"Velvet."			
Velvet by Lyon	161.	40.	15.	62.	38	316
Calculated	156.4	52.1	17.4	52.1		
Lyon by Velvet	320.	107.	34.	102.	8	571
Calculated	316.7	105.6	35.2	105.6		
Velvet by Yokohama	231.	72.	25.	75.	4	407
Calculated	226.7	75.6	25.2	75.6		
					Total . . .	1,294

that the intermediate formed only about one-twelfth of the whole number of downy plants. A minority of downy pods had more or less erect hairs, and a few had sparse down. The hairs were either yellowish or white.

The "Velvet" plants had sometimes stiffer tomentum than that of the Velvet bean, and more straight hairs. Some

THE THIRD GENERATION.

STINGING PLANTS.—Thirty-six stinging plants, from the second generation of the Velvet-Lyon cross, had the majority of their surviving progeny in each family stinging, when their seeds were grown among crowded sorghum in an elimination test (*see* Rept. of the Fla. Agr. Exp. Sta. for 1912, pp. 115-127).



STINGING BRISTLES OF HYBRID

Bristles from a ripe pod of the Velvet x China F1 hybrid, mounted in water. Most of them contain air. Scale in tenths and hundredths of a millimeter. (Fig. 13.)

Black plants were seen in several families, but apparently none survived to produce pods. Sixteen of these 36 plants had 15 or more survivors. Out of these 16 families,

(1) 3 were all stinging;
(2) 9 were stinging and downy;
(3) 3 were stinging and "Velvet";
(4) 1 was stinging, downy, and "Velvet."

The calculated numbers are:

(1) 1.8 families, constant stinging;
(2) 3.6 families, 3 stinging to 1 downy;
(3) 3.6 families, 3 stinging to 1 long tomentum (mostly "Velvet," a few long black);
(4) 7.1 families, 9 stinging to 3 downy to 1 "Velvet" to 3 black (or recessive downy).

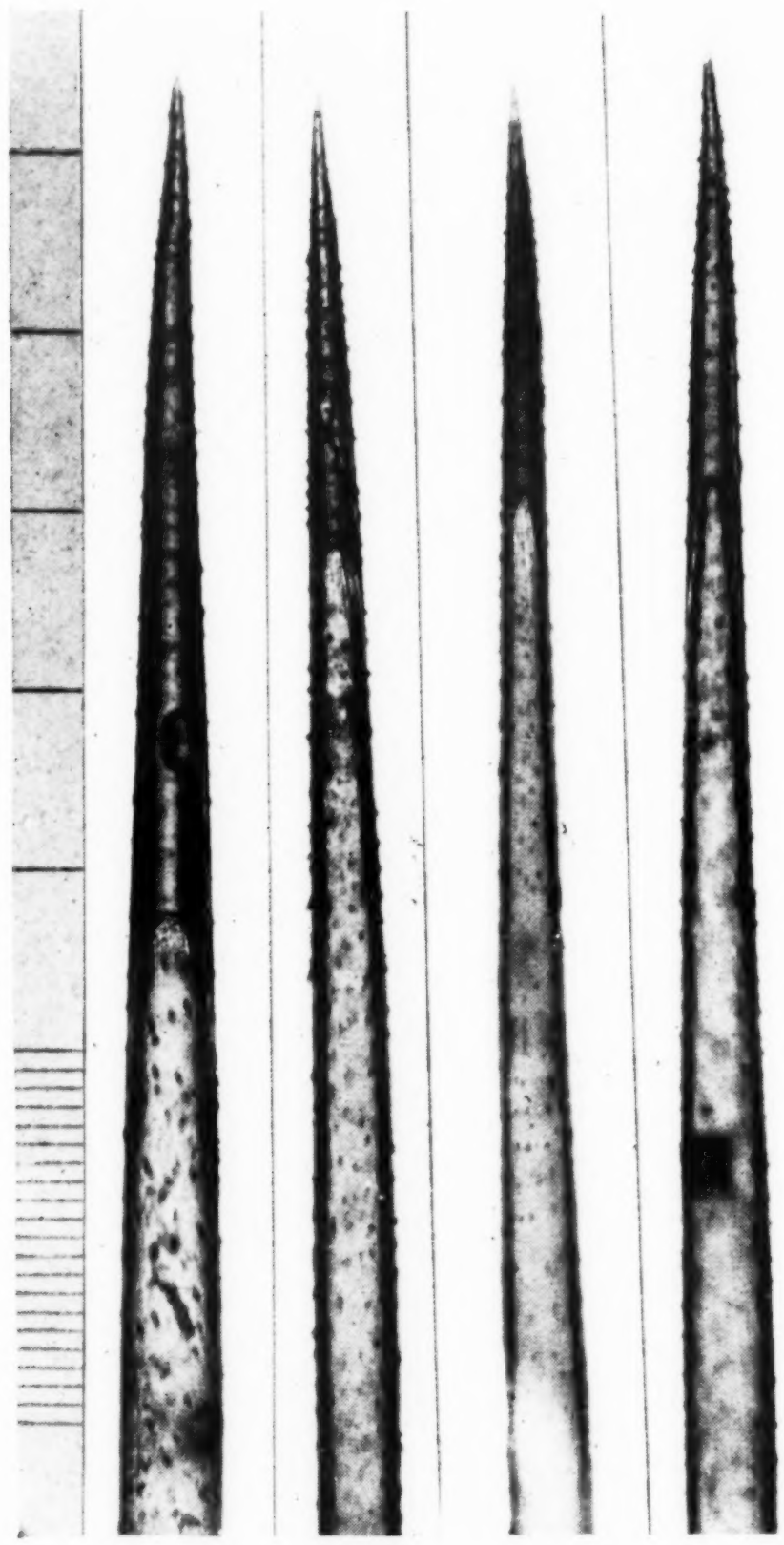
The elimination of the black plants would cause a few of class (3) to appear as class (1); and, together with the small size of the families, would cause most of class (4) to appear as class (2). Hence the numbers of different classes of families of stinging parents point to a segregation with two main factors.

DOWNY PLANTS.—Out of 22 families, six were constant; and 16 segregated into downy and smooth black. Fourteen of these segregating families were grown on poles. Their totals were:

	Downy	:	Smooth Black.
	311	:	118
(Calculated	322	:	107)

From seven downy plants of one of these F3 families, seven families were raised in F4. One was constant, and six segregated as follows:

	Downy.		Smooth Black.
	157	:	57
(Calculated	160.5	:	53.5)



TIPS OF STINGING BRISTLES

The first is from the wiid *S. pruritum*, and contains much gum in the point. The second, thirdand fourthare from F1 plants of Lyon x Velvet, Velvet x Yokohama and Velvet x China, respectively. They are indistinguishable, and contain less gum. Scale in tenths and hundredths of a millimeter. (Fig. 14.)

From one of these smooth black plants, a constant seedling family was raised in F5.

Hence the segregation of the progeny of heterozygous downy plants is,

Downy.		Smooth Black.
3	:	1

Figs. 16 and 17 show respectively downy and smooth black plants of the fourth generation. A pod of one of these smooth black plants is shown in Fig. 8*d*. The pods of these particular downy plants were not unlike the China pod shown in Fig. 8*b*.

"VELVET" PLANTS.—Out of five families, three were constant "Velvet," and two segregated into,

	"Velvet."		Recessive Downy.
	21	:	7
(Calculated	21	:	7)

The recessive downy plants have long appressed silky down (up to one millimeter) on their pods, and a patch of black tomentum on the calyx like the "Velvet" plants.

From a "Velvet" plant of one of these families, two families were raised in F4 and F5, which segregated into,

	"Velvet."		Recessive Downy.
	33	:	10
(Calculated	32	:	11)

From one F4 recessive downy plant, a constant family was grown in F5.

Hence the segregation of the progeny of heterozygous "Velvet" plants is,

"Velvet."		Recessive Downy.
3	:	1

LONG BLACK PLANTS.—Only three families were grown in the third generation. Their parents were selected for maximum crop. One F2 parent with weak tomentum gave in F3,

	Long Black.		Smooth Black.
	35	:	15
(Calculated	37.5	:	12.5)

Two F2 parents with stiffer tomentum gave in F3,

	Long Black.		"Velvet."
	44	:	17
(Calculated	46	:	15)

From one of these last families, several families were grown in F4 and F5. Most of the long black segregated, but some were constant. The "Velvet" were constant.

Hence the progeny of some of the F2 long black plants segregates into,

Long Black.		Smooth Black.
3	:	1

Others segregate into,

Long Black.		"Velvet."
3	:	1

Most of the F2 long black plants yield very poor crops.

VARIETIES OF POD HAIR

The first is a typical stinging bristle from the Velvet x China hybrid. The second and third are typical fine downy hairs from the Lyon and China beans, respectively. The fourth is a long, coarse downy hair from the Yokohama bean. The fifth is a hair of long tomentum from the Velvet bean. The sixth is one of the longest hairs of the fine tomentum on the smooth, black pods found in the second generation hybrids. Scale in tenths and hundredths of a millimeter. (Fig. 15.)

FINE DOWNY PLANT

A fine downy plant of the fourth generation, photographed early in September, and flowering freely. This belonged to the family of VL-515, of which seven lines were grown in F4. One of these gave 51 plants resembling this one, with fine downy pods; and the six others gave 157 plants like this and 57 smooth black plants such as shown in Fig. 17. There were thus in the field 208 plants, all closely resembling the one photographed above. By November, all these plants were bare of leaves and covered with dry pods. They were a week or two earlier than the Velvet bean. The hairs on shoots and leaves are white; the leaves are distinctly wrinkled. Scale in feet. (Fig. 16.)

SMOOTH BLACK PLANT

This plant belonged to the same family as the one shown opposite. Six fine, downy F3 plants gave each in F4 about one-quarter of these black plants. This photograph was taken early in December, 1912, but the plant presented much the same appearance early in September. This particular black plant set *no* pods, as all its minute flower-buds, or its few flowers, dropped. Some of the 57 black plants (brothers or first cousins of this one) set a few pods, but *all* kept their leaves until the frost of December 26. The leaves are smooth and convex; all the hairs on the plant consist of black tomentum. Scale in feet. A remarkable segregation with a single factorial difference. (Fig. 17.)

SMOOTH BLACK PLANTS.—Seedling families were raised from three F2 plants which produced enough ripe seeds. One family was constant black, and two families segregated into,

	Black.		White.
	53	:	18
(Calculated	53	:	18)

Hence the progeny of heterozygous smooth black plants segregates into,

Black.		White.
3	:	1

The pods of these recessive white plants have not been seen. Most of the F2 smooth black plants yield no crops.

WORKING HYPOTHESIS.

If B is a positive genetic difference (or factor) which the Velvet bean lacks, but which is present in the Lyon, Yokohama, and China; and C is another genetic factor, present in the Velvet bean, but absent in the other three; and *both* B and C (either single or double) are needed for the production of typical stinging bristles; then in the second generation,

(1) The stinging plants have both the factors B and C, single or double,
(2) The downy plants have only the factor B, single or double;
(3) The long black and "Velvet" plants have only the factor C, single or double;
(4) The smooth black plants have neither B nor C.

If D is a genetic factor, present in the Lyon and Yokohama, but absent in the Velvet bean, which factor, in the absence of B, causes the formation of black tomentum all over the plant; if between factors C and D there is a partial repulsion, so that they *rarely* enter the same gamete; then,

(1) Plants with neither C nor D will be very rare in F2;
(2) Plants with both C and D will be about twice as numerous in F2 as plants with only C; most of the former will have single, and most of the latter double factors;
(3) Plants with D only will mostly have this factor double, and will be about half as numerous as plants with both C and D.

We have then for the segregation in F2:

(1) Nine-sixteenths, stinging plants, all with B and C, about two-thirds with D (mostly single), and about one-third without D;
(2) Three-sixteenths, downy plants, all with B, and nearly all with D (mostly double);
(3) Three-sixteenths, plants with long tomentum, all with C, about two-thirds (long black) with D (mostly single), and about one-third ("Velvet") without D;
(4) Nearly one-sixteenth, smooth black plants, without B or C, all with D (mostly double);
(5) A very few, recessive downy plants, without B, C, or D.

This hypothesis needs confirmation, especially by crossing and back-crossing the constant lines in F6.

Eugenics Research Association

The Eugenics Research Association, an organization composed largely of field workers on various cacogenic lines, held its second annual meeting at Columbia University on June 19 and 20, with an attendance varying from 50 to 75. A number of good papers were read, and much time devoted to a discussion of practical problems, during which considerable dissatisfaction was expressed with the idea that feeblemindedness is a "unit character," Professor R. S. Woodworth of Columbia University declaring that eugenics could not hope to gain the support of psychologists until it had either proved or abandoned this hypothesis. Professor J. McKeen Cattell of Columbia University was elected president and William F. Blades of the Eugenics Record Office re-elected as secretary-treasurer. Dr. Jean Weidensall of the Laboratory for Social Hygiene, Bedford Hills, N. Y. and Dr. A. J. Rosanoff of Kings Park Hospital, N. Y., were chosen as directors to fill three-year terms.

THE DECLINING BIRTH RATE

Better Classes of Population in United States Marrying more Frequently and at Earlier Age than in the Past, but Number of Births Decreases—Cause of Fall Mainly Psychological—Interests of Individual Versus Interests of Race.

F. H. HANKINS,

Professor of Political Economy and Statistics, Clark University, Worcester, Mass.

IT IS a self-evident fact that when death-rates begin to exceed birth-rates in any race or nation it is only a matter of time until that race or nation is supplanted by another in which there is an annual increase in numbers. History shows that racial stocks with a redundant fertility have flowed out from ancestral homes to take possession of new territory. Likewise military strength and survival have been at times roughly proportional to numbers. Industrial and commercial prestige is also roughly proportional to population among nations of approximately the same stage of economic development. Differential decline in birth-rates therefore tends to upset the comparative standing of races and nations. Moreover and most significant of all, a checked birth-rate reduces the operation of natural selection and thus tends to interfere with the process by which man increased in physical strength and intelligence.

More than a century ago Malthus declared that there was a tendency for population to increase faster than the means of subsistence. Observing the great mass of poverty and degradation in contemporary England, he was led to the belief that numbers of a population must be kept within bounds by famine, pestilence, poverty, vice, crime, and war. Malthus pointed out that the only way to obviate the operation of these positive checks was the introduction of the negative check upon population increase. By this he meant moral restraint, including thereunder both postponement of marriage and continence within the marriage relation. A century's experience has shown that food supply and the conveniences and comforts of life can be multiplied by man's inventive and industrial capacities more rapidly than the population increases. Doubtless no period in the world's history has shown an equal increase in numbers of the white or civilized races. Nevertheless the white world's supply of consumable goods has increased several fold per capita. We are, therefore, today under the necessity of considerably modifying the Malthusian formula. There is, experience shows, no inevitable and fatalistic tendency among advanced nations for population to increase beyond bounds; but there is in every social rank a consciousness of the conflict between reproductive forces and the desires for wealth, education, recreation, leisure, social position, foreign travel, and other features of an advancing standard of living.

PRESSURE IS INTENSIFIED.

It is now well established that the pressure of population which Malthus laid so much stress upon is not a pressure upon the means of subsistence, but rather upon the standards of living. Moreover recent experience would seem to indicate that this pressure is intensified rather than reduced by an increase in wealth, so that the size of the family tends to diminish as one ascends the social scale. Malthus's error therefore was in the supposition that population would forever tend to expand with its material basis. At the very time when the thinking people of Western Europe were thrown into a most profound pessimism by his treatise, there was

SMOOTH BLACK PLANTS.—Seedling families were raised from three F2 plants which produced enough ripe seeds. One family was constant black, and two families segregated into,

	Black.		White.
	53	:	18
(Calculated	53	:	18)

Hence the progeny of heterozygous smooth black plants segregates into,

Black.		White.
3	:	1

The pods of these recessive white plants have not been seen. Most of the F2 smooth black plants yield no crops.

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beginning in France and America an actual decline in the birth-rate. This decline did not become pronounced in Western Europe until the decade 1870 to 1880. It is more than a coincidence that at this same period Mrs. Annie Besant and her confrères in Theosophy began openly to advocate New-Malthusianism. They contended that the number of children in a family should be consciously limited. To this extent they agreed with the moral restraint doctrine of Malthus; but they did not advocate the postponement of marriage, but rather interference with the normal processes of reproduction. Since the late seventies the entire Western world has silently acquiesced in this doctrine, so that we find today that contrary to the expectation of Malthus, our world is no longer in the mysterious and inexorable grasp of nature's demand to increase, but rather man is achieving control of his own perpetuation. This control is spreading to all ranks of the population so that for the first time in history the conflict of a democratic demand for high standards of living with the forces of sex and race responsibility threatens the perpetuation of entire nations. Man's expanding knowledge gives him the true freedom which comes from a conscientious and intelligent control of his environment and his own destiny, but of all his achievements none is so momentous for the future as the control over the forces of his own generation.

HERBERT SPENCER'S THEORY.

Another very interesting historical theory of population is that set forth by Herbert Spencer in the early fifties. The main thesis which Spencer sought to demonstrate is that there is a direct and unalterable opposition between individuation or individual development and genesis. His fundamental contention was that the surplus energy of an organism has two possible uses—individual growth or activity and multiplication. He showed that as animals grow in size, and above all as their nervous systems become larger and more complex the number of their offspring becomes smaller. As the individual of a species becomes highly developed and therefore able to compete more successfully with its natural enemies, the balance of nature requires that the offspring shall diminish in number. A codfish, countless numbers of whose eggs and young will be eaten, must spawn a million eggs to produce one mature descendant, but not so with the shark, the elephant, or man. Now, without going further into Spencer's reasoning, we may see here a fundamental principle to guide us in considering the problem before us.

In the earlier stages of social evolution the possibilities of individual development were narrowly restricted by the necessities of racial subsistence and perpetuation. But as man achieved a larger and larger control over nature, as he acquired knowledge and material goods, the importance of the individual increased, until in modern societies the perfection of the individual personality has come to be the chief end of social endeavor. It is among those peoples and classes where the number of offspring is greatest that individual development is lowest. On the other hand progress in knowledge and the spread of the fruits of civilization to the lower class is everywhere accompanied by a decrease in the size of the family and an increase in individual development. But if the forces of individuation, that is the opportunities and desires for personal achievement and enjoyment, outrun the forces of genesis, that is the obligations to the race, civilization will defeat itself by producing race suicide.

There is still another generalization from Spencer of special interest in this connection. He laid down as the final criteria by which one may judge the stage of evolution of the family the following principles: the first end of the family is perpetuation of the species; the second is the welfare of the offspring; and the third the welfare of the parents. That form of family is best which fulfills in due proportion all three purposes. He therefore drew the conclusion that that form of family is highest in which the period preceding reproduction is lengthened; in which the number of offspring is reduced to the minimum consonant with the perpetuation of the species; in which the lives of parents are

least subordinated to the rearing of offspring; in which the period following the cessation of reproduction is the longest possible; and in which finally the offspring themselves find pleasure in caring for parents in their old age.

PRINCIPLES ARE APPLIED.

These principles are in harmony with the progress of the family in recent times. There is a tendency among the upper classes to postpone marriage; the number of children is smaller, but not so small as yet, except in France, as to endanger the life of the race; a larger proportion of them are reared to maturity, they receive much greater individual attention, are better educated and given a better start in life; parents live longer and have a larger proportion of their lives freed from the care of children than formerly; and finally aged parents are more solicitously safeguarded than ever before. Here again we find that a decline in the birth-rate is in harmony with a higher type of family. But here also we must note that there is a conflict between some ends and others. The fundamental purpose of the family as a social institution is the perpetuation of the species; it is this which makes the family so profoundly important; it is this which accounts for the extraordinary care with which society at all stages has safeguarded it by numerous restrictions and requirements. When therefore the pleasure-seeking of parents, or their welfare in any other regard, which is the third purpose of the family, comes to dominate the racial responsibility which is its first purpose, then it is no longer in harmony with the conditions which a permanent society is bound to enforce.

Space does not permit a statement of the extent of the decline in the birth-rate. It is generally known that every Western nation is experiencing a decrease in its birth-rate. It is also a matter of common knowledge that this phenomenon is disturbing the balance of power and raising questions of the greatest political and military significance.

When it comes to the causes of this decline there is less unanimity. This is one of the subjects in the explanation of which causes stated often prove merely a presentation of the personal biases of their propounders. Only the more important can be noted here.

It is commonly thought that an important factor in the decline of the birth-rate is the postponement of marriage. The statisticians of a decade or more ago were accustomed to show a close correlation between the marriage rate and the birth-rate. The marriage rate varied either directly or indirectly as did economic conditions, and the births followed a similar course a year or two later. But now this connection is being seriously disturbed. In France there has been a very slight decrease in the proportion of persons under 20 who are married; but this has been more than offset by an increase in the proportion of those of ages 20 to 30 who are married. Indeed in Europe generally the proportion of persons under 30 who are married is increasing except in England and Scotland. Moreover on the whole marriages take place earlier in France than in England, Germany, or America. Nor is this all, for a larger proportion of the French population is married than in any of these other countries. Thus the birth-rate in France has continued to fall in spite of those very conditions which should have sustained it or even caused it to increase.

IN THE UNITED STATES.

In the United States, contrary to popular opinion, marriages are not only more numerous but are contracted at earlier ages than they were 20 to 25 years ago. Thus when comparison is made of the censuses of 1890, 1900, and 1910, it is found that the proportion of the population classed as single has steadily diminished and the proportion of married has steadily increased. Moreover this is true of both sexes. When a study is made of conjugal condition by all classes one is astonished to find that a larger proportion of young men of age groups 15-19, 20-24, and 25-34 were married in 1910 than in 1890 or 1900; and that a larger proportion of young women of ages 15-19 and 20-24 were married in 1910 than formerly. One is therefore forced to the conclusion that if we view the population of the United States as a whole marriage is

neither avoided nor postponed as compared with a decade or two ago, but that on the contrary it is more general than heretofore and is undertaken at earlier ages.

If now we carry our inquiry a little farther we meet with other surprises. The census classifies the population under four headings, Native White of Native Parentage, Native White ot Foreign or Mixed Parentage, Foreign-Born White, and Negro. The returns show that in every one of these four groups there was a larger proportion of married among both sexes in 1910 than in 1890, except among Foreign-Born Whites where the proportion was practically the same (62.2 in 1890 and 62.1 in 1910). Moreover when age groups are studied, one finds that the proportion of married is greater in 1910 than in 1900 or 1890 in all four nativity classes for both males and females of ages 15-19 and 20-24; and that this is also true for both sexes and all four classes in the age group 25-34, except among foreign-born males where the proportion in 1910, though larger than in 1890, was slightly smaller than in 1900.

We are forced therefore to conclude that in all nativity classes of the population as in the population as a whole there is a tendency for the proportion of persons married to increase and a tendency for marriages to be undertaken at an earlier age. This is a very unexpected result with respect to the native whites of native parentage. This class includes those whose parents were born in this country; it is to this class that the professional and propertied familes belong and it is frequently asserted that this class is avoiding marriage to an extent that shows a decline in their sense of social responsibility. While it is true that marriage is later in this class than among artisans and unskilled laborers, and while in certain strata of this class the age of marriage is doubtless later than formerly, nevertheless taken as a whole it is undertaking marriage as readily as, and even more readily than, in past decades.

Numerous other causes have been brought forward by the French students of this phenomenon. The style of women's dress; over-eating, especially consumption of meats; over-refinement; salacious literature, the theatre and other excitants of morbid cravings are believed by some to be causes. Then much stress is laid upon physiological sterility; but statistical evidence seems to minimize its significance. Doubtless considerable importance must be attributed to venereal infections.

CAUSE IS PSYCHOLOGICAL.

But magnify as we may all other causes of the decline, the fact remains that the one conspicuous factor is the changed psychological attitude toward the size of the family. This change in attitude has a great variety of causes. In the first place the very possibility of escaping the normal consequences of natural instincts in this regard would prompt general adoption of the means thereto. Have not various inquiries shown, and is it not self-evident fact, that women have in the past been held in the iron grasp of an inexorable fate which has imposed upon them in a large proportion of cases the complete sacrifice of themselves to a monotonous round of drudgery and child bearing? The increasing freedom of woman, the growing power and importance of her personality, the inevitable demand on her part to be recognized as an equal in the responsibilities and the honors of racial achievement; all these have reacted upon the size of the family. There has in addition been a great decline in religious control; the most Catholic department in France has had in recent years an excess of births over deaths seven times as great in proportion as the rest of the country.

Then there is the imitation of the rich by the poor, of the social élite by all others. It has been and still is true that the big families live in the little houses and the little families in the big houses; but more and more generally it is becoming true that the children who grow up in the little houses are demanding the education, the training, the leisure, the social opportunities of those who grow up in the big houses, and their parents are ambitious to give them every possible advantage. Here indeed is the great central fact,—individual ambition.

Here is Spencer's principle of the tendency of progress to magnify and exalt the individual personality; here also is his principle that social advance is accompanied by a decreasing sacrifice of parents to racial demands.

Now this of course has its good and its bad features. There may be individual ambition which takes the direction of pure sordidness—the excessive selfishness of the woman who will not surrender a part of her inconsequential and socially valueless card playing and dancing or of the man who doesn't want to share any of his income or his property and the freedom they give him. Now it is equally true that neither matrimonial concubinage nor brutal, soul-destroying selfishness are socially justifiable. Individual ambition may on the other hand take the direction of social achievement. It is undoubtedly true that children are an impediment to the man or woman who would win fame in business, science, literature or art. But here what society loses in talented offspring is in part counterbalanced by greater present achievement. Individual ambition may and now frequently does take the direction of a desire for the better training and equipment of children for the duties of life. When, however, the combination of ambition for the child and selfishness and fear on the part of the parents results in the one-child family, it often happens that the child has lost more by the absence of brother or sister than he has gained by the increased chance of a good start in life.

PROPER SIZE OF FAMILY.

There is, I believe, nothing that promises more for the solution of problems of poverty, low wages, economic inequality and kindred social problems than the fact that parents are acquiring the power to determine in each case what their family should be, but there must be a golden mean between none and a dozen which represents the socially desirable. If three or four children for each fruitful marriage are necessary to maintain the population in a stationary state, then three, four, or five children must represent the family which society would profit by standardizing. While individuals of great genius may here and there profit by complete freedom from early struggles, it nevertheless remains true sociologically that a race which is to remain strong and progressive must develop in its youth a sense of self-reliance and a willingness to undergo hardships which cannot come when all needs from childhood to manhood are provided by the paternal pocketbook.

It is extremely difficult in practice to get the wisest proportioning of size of family and economic resources. A truly democratic system would require many children of the rich and few of the poor; this would quickly destroy class divisions. The rich, the well-to-do, the professional classes maintain their supremacy in the social system partly because their numbers are small and unskilled laborers do the meanest work at the lowest wages because their numbers are large. But a more ideal social arrangement will be that in which the number of children is so related to the economic status of the family that individual ambition will not be killed by the enervating effects of luxury on the one hand or the demoralizing effects of poverty on the other. Such an arrangement would permit most rather than the favored few to share the fruits of civilization, would so enlarge the opportunities of the lower classes that society would get the benefit of much talent at present smothered by the grime and toil of economic insecurity.

There are those conspicuous in the councils of the nation who urge upon all the public duty and the personal joys of large families. But there is reason to suppose that the unfit are now multiplying more rapidly than the fit. And in the second place the chief fault with modern society is that it has too many poor, too many at the bottom already. What we ought to work toward as a public policy is the reduction of the great mass of unskilled labor and the consequent equalization of economic opportunities. Of course there are different ideals of what society ought to be. Some prefer great masses of people, large volumes of imports and exports, great armies and the pomp and noise of a world power; and they prefer these things even though they be purchased

at the expense of great inequalities, much poverty, and a low standard of public life. Others prefer a greater equalization of wealth, a juster distribution of life's opportunities, increase in the general intelligence, and achievement in civilization rather than in money making. We hear of many philanthropic measures to better the condition of the poor, but there is no proposal which will be so efficacious in the elevation of their status as the reduction of their numbers. The propaganda now being carried on by the Neo-Mathusians and the Socialists among working people, whatever may be its other social consequences, will raise the economic and social status of those whom every true democrat devoutly wishes to share in the best that life affords.

A DIFFERENTIAL DECLINE.

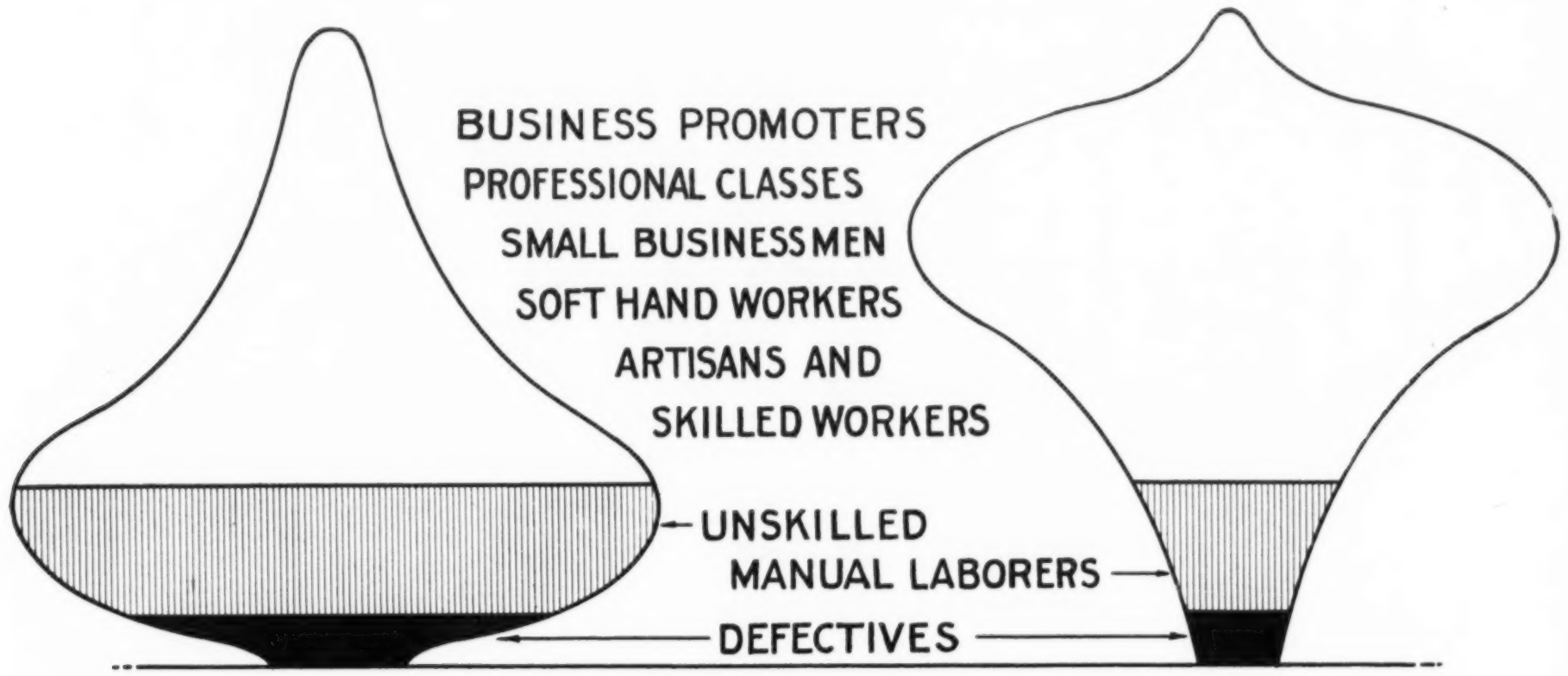
Another important feature of this whole problem is the probability that the decline in the birth-rate has affected the better stocks more generally than the poorer, with the result that Western nations are now reproducing themselves mainly from the less able. This would gradually shut off the supply of talented men, of geniuses, of men who invent, discover, and create, of men who set new standards and lead to the performance of new duties. This would be to add to race suicide the evils of racial decay and degeneration. By the lavish provision of homes, asylums, and charitable agencies of all sorts we make it easy for the lazy, the shiftless, the immoral, and the defective to multiply apace; and by the growth of sanitary and medical science we are preserving a larger and larger proportion of those whom nature would pronounce unfit.

When it comes to a comparison of the different economic classes there are those who hold that differences in rank are due entirely to differences of ability; then there are those who hold that natural abilities are about equally distributed among all classes. It is frequently argued that the one great misfortune of the poor is their poverty and that accident and good luck have played a leading rôle in the elevation of those who happen to be at the top. Undoubtedly there is much truth in this; social arrangements are not just; opportunities are far from equal. But in a land where opportunities have been large and moderately well distributed, achievement becomes in a rough way an index of ability, and failure for several generations marks a family as of mediocre blood. In any case the probability that talent is altogether as frequent among the lower classes as among the upper would seem to be small. The social problem with reference to the masses, even though they should be equally talented with the classes, is to so reduce their numbers and enlarge their opportunities that the inherent talent they do possess may become socially creative. At the other end of the social scale the problem is to secure a perpetuation and increase of those with natural ability.

But the statistics of college graduates indicate that a smaller proportion of them marry than some decades ago, that the age at which they marry is later, and that the number of children has fallen steadily and sharply. It surely cannot be argued that there is no social loss when families who have achieved education and economic freedom fail to maintain their places in the social composition.

On the other hand numerous studies by Eugenics Laboratory and University of London students, by Rowntree, Charles Booth, and others in America and Europe show that the lower the wages, and therefore the natural ability, the larger the family. As one ascends in the economic scale the size of the family diminishes. However much one may be impressed with the obvious inequalities of modern social arrangements and the undoubted exploitation of those rendered helpless by poverty the evidence of such facts as just cited forces the conviction that there is a tendency for advanced nations to die at the top and to be replenished too abundantly from their less able stocks.

Unless we can somehow find a way to make income proportional to inherent ability and the size of the family roughly proportional to income our civilization will neither meet the requirements of social justice nor the essential conditions of its own permanency. Just how this



WHAT A EUGENIC REFORM WOULD MEAN

The accompanying charts show respectively the distribution of economic classes in present society (at the left) and the distribution that would result were size of family to be roughly proportional to income and native ability; were also negative eugenics to be used to prevent the multiplication of the defective; and were the educational opportunities of the industrial classes greatly increased (at the right). These charts are merely suggestive: proportions and class designations are not exact. (Fig. 18.)

is to be done is another matter. Rome's efforts to preserve her best blood by legal requirements failed. Recent French proposals include the education at public expense of every seventh child in a family; the taxation of bachelors and the exemption or abatement of taxes of fathers of large families; additional votes to fathers in proportion to the size of their families; a public bounty of 500 francs for the third and every additional child. All these and numerous other proposals lack an essential quality—they are indiscriminate and uneugenic. They would probably have the sole effect of increasing the proportion of the inefficient; they might increase numbers but they would hasten degeneration.

There are those who believe that the decline in the birth-rate cannot be checked; and it does seem that civilization tends to commit suicide by freeing the individual and enabling him to flout the race. Is it possible that a race can be kept alive only by maintaining a substratum of poverty-stricken, brute-like creatures upon whom must rest not only the weight of ceaseless toil, but the burden of renewing the ever-disappearing cultured but enervated social favorites? Can we destroy poverty, and with it the grosser injustices of our crude anarchistic social system, elevate the whole mass of the nation to sharers in the fruits of civilization and at the same time not bring self-destruction to our white blood but rather raise its quality above the best the world has yet seen? If we still wish to be optimistic we may reflect that ours is perhaps a period of transition; that man's new knowledge must ever give him added responsibility as well as increased liberty; and that there is much hope for both a finer social order and a higher type of man in the education of coming generations in what is eugenically fit and in the social responsibilities required by an altogether new and momentous power.

Need of Family Histories

The investigation of human eugenics—that is, of the conditions under which men of a high type are produced—is at present extremely hampered by want of full family histories, both medical and general, extending over three or four generations. Believing, as I do, that human eugenics will become recognized before long as a study of the highest practical importance, it seems to me that no time ought to be lost in encouraging and directing a habit of compiling personal and family histories.—Francis Galton: Inquiries into Human Faculty (1907).

INBREEDING IN DOGS

Statistical Study of the Pedigrees of Two Typical Breeds—Inbreeding Not so Commonly Practiced by Dog Fanciers as Popularly Supposed and Not so Productive of Results as Line-Breeding.

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THAT the thoroughbred dog is very closely inbred is the belief shared alike by the general public and breeders of other kinds of stock. Upon this belief are based most of the objections raised against the thoroughbred either as a companion or a hunting dog. Among dog fanciers, one hears both extravagant praise and bitter denunciation of inbreeding.

In certain studies I have recently carried on in terrier breeding I was collecting some data from the stud book records, and I determined at the same time to discover, if possible, what proportion of registered dogs are inbred and whether or not these inbred dogs had been markedly successful in bench show competitions. The results are surprising and furnish some interesting conclusions on the comparative value of in- and line-breeding.

For this analysis I selected two breeds, the Airedale and Scottish terriers. Both belong to the same general family: both are popular: both have known histories and carefully compiled records. But each has a very distinct origin, and neither is in any way related in blood. The Scottish terrier[1] came from the Highlands where they have been known as a distinct breed since the Sixteenth Century. They are the oldest breed of terriers that have been preserved in anything like their original form. The Airedale terrier,[2] on the other hand, is a manufactured breed which originated in Yorkshire something over fifty years ago.

Selecting at random, but picking half from each sex and 10 from each volume of the stud book for the past 10 years, in 100 Scottish terriers we find three inbred dogs, one from a sire bred to his own daughter, one from a dam bred to her son, and one from full brother and sister. Selecting 100 Airedale terrier pedigrees in the same manner, we find seven examples of inbreeding, six from a sire bred to his daughter and one from a full brother and sister. In other words in the pedigrees examined, 3% of the Scottish terriers and 7% of the Airedales are inbred.

BREEDING CHAMPIONS.

The avowed object of breeders of these dogs is to produce a dog that shall win at the bench shows. The highest honor a dog can receive is the right to the title of Champion, which means that it has won a certain number of first prizes under at least three different judges. The rules differ somewhat in detail in England and this country, but the underlying principle is the same. While there are undoubtedly dogs that in fancier's phraseology are known as "lucky champions," still it is safe to say that dogs winning the title are above the average quality of their breed, closer to the ideal as expressed in the standard. Moreover since to breed champions is the object of the fancier's breeding operations, the per centum of

[1]Davies, C. J., The Scottish Terrier, London, 1907.
McCandlish, W. L., The Scottish Terrier, Manchester, Eng., 1909.
Haynes, Williams, Scottish and Irish Terriers, New York, 1912.

[2]Buckley, Holland; The Airedale Terrier, Manchester, Eng., 1907.
Haynes, Williams, The Airedale, New York, 1911.
Jowett, F. M., The Airedale Terrier, London, 1912.
Palmer, R. M., All About Airedales, Seattle, 1912.

	Average dogs.	Champions.
SCOTTISH TERRIERS		
Inbred	3	1
Line-bred	4	9
Out-bred	93	90
AIREDALE TERRIERS		
Inbred	7	2
Line-bred	6	10
Out-bred	87	88

NOTE.—The "Line-bred" in the above only includes dogs bred from the primary cross of half brother to half sister, and there are certainly dogs in the "Out-bred" that are truly in-bred.

inbred dogs winning championships furnishes a gauge to judge the effectiveness of this breeding system in accomplishing the result desired by the breeders of these animals.

Of 100 Scottish terrier champions, one is inbred, from a dog mated to his own daughter. Of 100 Airedale champions, two are inbred, one from a bitch mated to her own son and one from full brother and sister.

LINE BREEDING.

In the case of line-breeding, however, we get very different figures. Taking only the two primary crosses of line-breeding, *i. e.*, the crossing of half brother and sister, sired by the same dog, and half brother and sister, dammed by the same bitch, which, of course, does not begin to include all line-bred dogs, we find that of the hundred Scottish terriers picked at random four are line-bred, all from half brother and sister with the same sire. Of the hundred average Airedales six are line-bred, five from half brother and sister with the same sire, and one from half brother and sister with the same dam. Among the hundred Scottish terrier champions nine were bred this way, eight from half brother and sister with the same sire and one from half brother and sister with the same dam; and 10 Airedales champions were so bred, nine from half brother and sister with the same sire and one from half brother and sister with the same dam.

It will be immediately noted in the above table that in- and line-breeding are more common in Airedales than in Scottish terriers, the ratio being close to two to one in all cases. Possibly this may be accounted for by the fact that being a manufactured variety, close breeding has been more or less forced because of lack of breeding stock. It will also be noted that the close breeding popularly supposed to be practiced by dog fanciers is not apparent. In the cases of the average dogs, only 7% of the Scottish terriers and 14% of the Airedales are closely bred.

The salient feature of these figures for the breeder is, of course, the evidence they present that line-breeding has, in the cases of these two breeds at least, proved very much more effective than in-breeding in accomplishing the object desired. The ratios of champions produced in Scottish terriers is 1 to 9, and in Airedales, 1 to 5. These figures confirm my studies in prepotency in Airedales.[3]

Summarizing the data, it is evident that neither inbreeding nor close line-breeding is used as much by dog breeders as is generally supposed, and that of the two systems line-breeding has been the more productive of results.

[3]Science, N. S. XXXVII, No. 977, pp. 404-405.

Mendelism in Man

Such rules (those of Mendelian heredity) have been demonstrated in operation for an immense diversity of characteristics in both animals and plants in great variety. It should be explicitly stated, however, that in the case of the ordinary attributes of normal men we have as yet unimpeachable evidence of the manifestation of this system of descent for one set of characters only, namely the color of the eyes.—William Bateson: Biological Fact and the Structure of Society (1912).

PIONEERS IN EUGENICS

Institute of Heredity Organized a Generation Ago, but Died Because Ahead of its Time—Object of Promoters to Advance Race Betterment by Study of Causes of Deterioration, by Better Breeding, and by Segregation of Defectives.

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BROWSING among the books in the library of the Eugenics Record Office, I happened on a quaint little brown covered volume stamped in gold with the one word *Heredity*.[1] I glanced it through and, charmed by its naive enthusiasm, sat down and read it with as much interest as though it had just come in hot from the griddle of a contemporary geneticist. It proved to be the correspondence between Elizabeth Thompson and Loring Moody, published in 1882 by The Institute of Heredity, in Boston. As the booklet has long been out of print and is probably a rare specimen of early eugenic literature, perhaps a few fragments from its pages would not be out of place in the light of day again.

"Having from early manhood," it begins, "been actively and earnestly engaged in various humane labors for the improvement and welfare of our race; having set on foot and organized several reformatory and benevolent movements; and having been a close observer of the practical workings and effects of these during nearly half a century; and from these having been led to a larger survey of the field, including all of our public and private charitable, benevolent and corrective institutions,—the conclusion is unavoidable that all of these institutions are at best only temporary expedients, for, while they afford some relief and a few instances of reform, they leave the roots and sources of evil untouched by their operations.

"This conclusion only led to another, viz., that in order to make any successful warfare against social disorders we must advance directly upon their strongholds, and dry up the fountains from which they spring. So I drew up the following circular, which with the aid of judicious friends—among them were Henry W. Longfellow, Samuel E. Sewall, and Mrs. Horace Mann—was printed and sent widely over the country—to the editors of several publications among others."

The circular stated what Mr. Moody considered the higher demands of humanity and announced his problem as being that of setting in motion such prenatal influences as should make the hereditary tendencies of future generations wholly good. "The generative power must be educated, trained and guided by the highest wisdom and scientific culture, as the only sure foundation of effective and permanent reform."

NO ADVANCE THROUGH PUNISHMENT.

"And for the reason that we have battled against effects," he continues, "while leaving causes in unchecked operation," have our reformative results been hopeless and unsatisfactory. "The causes are congenital. People who are born with theft and murder in the blood will steal and kill. The jailor and hangman neither cure them, nor check their

[1]Moody, Loring & Thompson, Elizabeth; Heredity: Its Relation to Human Development: Boston, 1882, Institute of Heredity, 159 pp.

tendencies, nor thin their ranks. For, as fast as we imprison and hang criminals others are born to take their places; so that all our conflicts with evil result in long-drawn battle."

"The true way of regenerating the race is through scientific generation. The demand of the time is, that we lay the right foundations of character by fixing the organic tendencies of children, in moral and physical health, before birth."

Mr. Moody evidently appreciated the need for that organization of knowledge which should give mankind the generalizations upon which it might work out this eugenic ideal and he earnestly hoped that persons of the highest wisdom, courage and devotion to public duty might come forward ready for this work, and take the first steps towards the formation of an *Institute of Heredity*, "which shall found a library, establish lectureships, with schools of instruction, and take in hand the diffusion of knowledge on the subject of improving our race by the laws of physiology."

The time was hardly ripe, when Mr. Moody wrote, for the founding of such an institution as he dreamed of, where "such conversations, consultations, and illustrated lectures as may awaken interest and lead on towards a realization of these great and beneficent ends" might be held. The school and lecture room in Boston, which he planned, together with its library which he hoped would grow into a research center, were not supported as he thought they might be and the first attempt at organization for eugenic investigation and research in America melted away.

Of the movement he says—and a considerable number of our newspapers and magazines have confirmed his prophesy—"It will encounter misunderstanding, opposition, and even ridicule and reproach, from ignorance, prejudice and bigotry. It must be sustained by the highest wisdom, prudence and forbearance. Hence it will need the sympathy and coöperation of every enlightened philanthropist and reformer."

FINDS ONE ADHERENT.

One such enlightened philanthropist and reformer, at least, responded to Mr. Moody's circular. In the little booklet, which seemed strangely lonely and out of place among the ranks of scientific memoirs and fat genealogies, are gathered some of the letters written back and forth between Mr. Moody and Mrs. Elizabeth Thompson who realized that she had been giving "much time, labor and money in aid of numerous schemes to palliate the evils of society, while leaving the causes of these evils to continue their destructive work."

"If I understand you rightly," she wrote, "You propose to carry a searching investigation into the causes of all the moral, mental and physical disorders of society, for the purpose of awakening a public demand for their removal. Will you please give me your opinions more fully as to the causes of these manifold disorders, and the conditions under which they are developed and transmitted from parent to child?"

Mr. Moody was not deceived by his ambition and ideal, he did not take the wish for the fact, he felt his lack of knowledge and in answering his enquirer he made the same reply as the conscientious student of eugenics would today—

"A glance at the roll of premature deaths, the ravages of disease, the records of our criminal courts, the tenants of our jails, houses of correction, reform schools, asylums for lunatics, idiots, inebriates; the abortions, infanticides, and other disorders and evils too numerous to mention,—will satisfy any thoughtful, reflective mind that the reproductive forces of the human race are terribly clogged and out of gear, and that the time has fully come for us to accumulate a groundwork of knowledge upon which we can move forward in the great work of delivering our race from this terrible waste, suffering and ruin."

NEGATIVE EUGENICS.

He also realized that, while more knowledge is of paramount importance to any attempt at racial improvement, there are some things that should be done immediately, and he outlined his plan of "negative eugenics" in a later letter.

"Then," he writes, "As a means of eliminating the inherited effects of disorders from posterity, I would have

the government establish and maintain good, comfortable, attractive hospital homes for the care, treatment and life residence of all habitual drunkards, confirmed criminals, idiots and incurable lunatics, who should be treated as people suffering from dangerous congenital diseases liable to propagate through heredity; and so they should be strictly guarded from having any offspring, as far as possible by moral, and the remainder by legal, restraint . . . These homes should be established in different localities, classified and arranged to meet the requirements of the patients afflicted with different disorders. Should we hesitate in view of supporting so many people in these homes, let us remember that their numbers would be constantly decreasing by natural causes, and as the wiser and better generation, which we shall in the meantime establish, will so cut off the supply that in a few generations there will hardly be any left; while by the present modes of treatment drunkards and criminals will be arrested, convicted and sent to prison over and over again for repeating their offences."

Then followed letter after letter brimming with facts drawn from observation and from the works of such scholars as Galton, Sharpe, Anthon, Ribot, Papillon and others like-minded in their views of national deterioration. Mrs. Thompson aided the work Mr. Moody had undertaken with her influence and with money so that some seed was sown, as witnesses the little book, but the dream of an Institute of Heredity was not realized until after Mr. Moody's death. One cannot but wish that the ghosts of such early pioneers could wander through the roomy buildings where records of inheritance are slowly accumulating day by day, and browse among the books of the library that has been started, and where their works may some day all be found, even as I chanced on this brown booklet today.

The Possibility of Eugenics

The improvement of our stock seems to me one of the highest objects that we can reasonably attempt. We are ignorant of the ultimate destinies of humanity, but feel perfectly sure that it is as noble a work to raise its level in the sense already explained, as it would be disgraceful to abase it. I see no impossibility in eugenics becoming a religious dogma among mankind, but its details must first be worked out zealously in the study. Over-zeal leading to hasty action would do harm, by holding out expectations of a near golden age, which will certainly be falsified and cause the science to be discredited. The first and main point is to secure the general intellectual acceptance of eugenics as a hopeful and most important study. Then let its principles work into the heart of the nation, who will gradually give practical effect to them in ways that we may not wholly foresee.—Francis Galton: Essays in Eugenics (1909).

Negative Eugenics

Having already defined positive eugenics as the encouragement of parenthood on the part of the worthy, we may define negative eugenics as the discouragement of parenthood on the part of the unworthy. It must be remembered that we shall not raise or regenerate the race merely by purging it of diseased elements, however necessary and desirable that process may be. Eugenists must beware of supposing that they have done any more than a preliminary piece of work, prior to a fair start, when they have achieved, say, the segregation of the feeble-minded.—C. W. Saleeby: The Methods of Race Regeneration (1911).

RECENT BOOKS ON HUMAN HEREDITY

AMEY EATON WATSON, *New York, N. Y.*

Schuster, Edgar—Eugenics; a Science and an Ideal. The Nation's Library. London. Collins, 1913. Price 1s.; pp. 264.

Attempts to give an account of the meaning of the word eugenics, the aims of those who advocate an eugenic policy and the more important of the problems which confront them. Endeavors to indicate, not only the conclusions arrived at by those best capable of judging but also the arguments on which their opinions have been based.

Von Hoffman, Geza—Die Rassenhygiene in den Vereinigten Staaten von Nordamerika. Munich. J. F. Lehmann, 1913. pp. XXI and 237.

Of great service to all who wish to make a serious study of eugenics, especially of Negative or Restrictive Eugenics. The author has been Austrian Vice-Consul in California and has spent several years in making a thorough study of these subjects. Concludes with a descriptive bibliography.

Reed, Charles A. L.—Marriage and Genetics: Laws of Human Breeding and Applied Eugenics. Galton Press, Cincinnati, 1913. pp. 183.

This book, from the pen of a surgeon, was written with a desire in some measure to overcome the ignorance which keeps people from protecting themselves and their offspring from disease and degeneracy. The foundation of its thesis purports to be the natural laws of human breeding inherent in the individual. While based largely on Dr. Davenport's "Heredity in Relation to Eugenics," this book is by no means so careful or scientific in its treatment.

Roper, A. J.—Ancient Eugenics. Oxford, Blackwell, 1913. Arnold Prize Essay for 1913.

Mainly historical, surveying the progress and practice of eugenic ideals from the time of barbarism in Sparta, Germany, Athens, etc. Quoting from the authorities of the times, Plato, Aristotle, Caesar.

Wormald, John and Wormald, Samuel. Guide to the mental deficiency act, 1913. London. P. S. King & Son, 1913. pp. 145.

Reviewed in the Eugenics Review, April, 1914. We are told that authors are physicians, having special qualifications for their task. Sections deal with (1) operation of the Act, (2) authorities under the Act, (3) administration of the Act, (4) offences against the mentally defective, (5) finance and statistics, (6) conclusions.

White, W. A. and Jelliffe, Smith Ely, Editors. The modern treatment of Nervous and Mental Diseases. Lea and Febiger, 2 volumes, 867 and 900 pp. respectively. Price $6.00 each.

The contributors to these two volumes include many of the best men in America and England; Havelock Ellis, Ernest Jones, Gordon Holmes, and S. A. R. Wilson. Of especial interest are the chapters on eugenics and heredity, alcoholism, and syphilis.

Thorndike, Edward L.—Educational Psychology, Vol. III, Mental Work and Fatigue and Individual Differences and Their Cause. Teachers' College, Columbia University, 1914. pp. X and 400. Price $2.12.

Chapter XI deals with the Influence of Immediate Ancestry or Family, summarizing many of the more important studies in human heredity that have recently been made and criticises them from the standpoint of modern psychology. A valuable discussion of Mendelian inheritance.

Saleeby, C. W.—The Progress of Eugenics. Funk and Wagnalls Co.

A new book by the English Eugenist promised for the late spring.

THE BARE NECKS

Some three years ago we purchased of a neighbor who had brought back with him from the Barbadoes two cocks and three hens characterized by the absence of feathers from the neck as far as from the ears down to the clavicle. In most of the hens there was a paired bunch of feathers on the ventral side of the neck; but one was practically free from feathers in that region and this condition has reappeared in her offspring. These birds are very sparsely feathered under the wings and over the sternum also.

The thing that interested me most was the hereditary behavior of this condition. Mated to each other these birds gave a few full-feathered chicks, but about three-fourths of all were bare-necked. Mated to ordinary fowl, about half of the offspring had naked necks—there was very little indication of imperfection of dominance. It appears, consequently, that the naked neck is a typical dominant and in accordance with current interpretations, one may say that there is a factor in the "Bare Necks" which interferes with the development of the neck feathers.

Some years ago I pointed out that the condition of clean shank is dominant over that of feathered shank in poultry. In the light of the later result one may generalize and infer that the typical (primitive?) condition of the fowl is this, that every skin plate bears a feather; and that if any portion of the skin is without feathers, it is due to a specific inhibitor to the development of the feather germ in that region. Of these inhibitors there are probably a number; there are at least one for the shanks and one for the neck and possibly an additional one for the ventral patch of the neck. So far as we have gone it seems probable that the inhibitor is of the nature of an anti-enzyme which interferes in a given area with the development of those enzymes that induce the formation of the feather. (Fig. 19.)

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